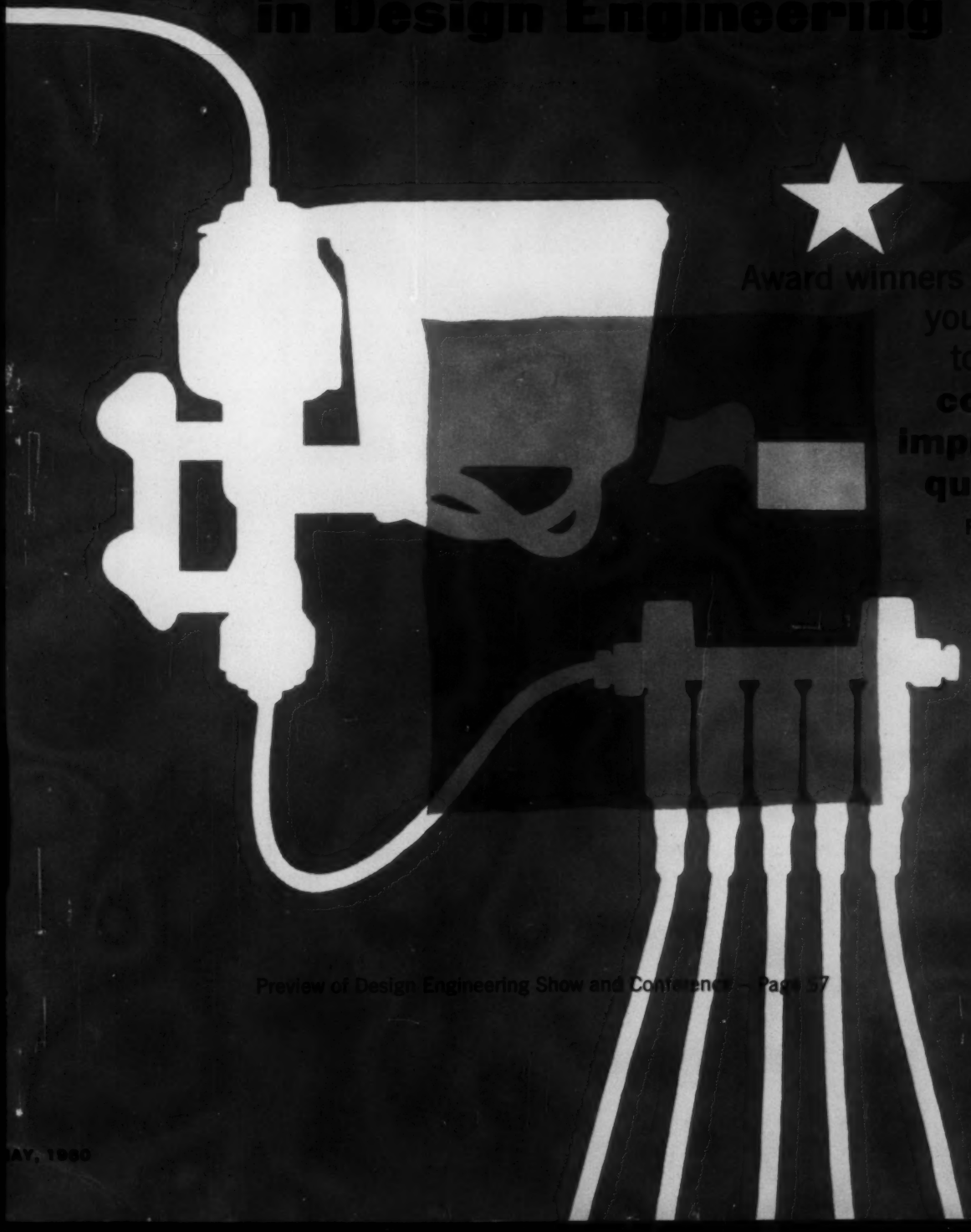
Materials in Design Engineering



Award winners show you how to **cut costs, improve quality**

Page 139

Preview of Design Engineering Show and Conference — Page 57

AY, 1980

Anaconda Memo to Management

Maybe zirconium copper wire is your answer

Looks like ordinary wire, but it's new and rather special. Amzirc®—zirconium copper, Cu 99.88%, Zr .12%—combines high electrical conductivity (90 to 95% IACS at room temperature) and strength retention at elevated temperature in the aged condition. Tensile strength of zirconium copper cold worked 80% and aged is about 70,000 psi at 20 C—52,000 psi at 400 C in a short-time test. Naturally, it has attracted interest in the missile field. We just recently finished drawing a batch of .0179″ wire for testing as a conductor in some missile components, and now know that even smaller diameters can be made. We also know it has excellent hot- and cold-working characteristics. But we don't have all the answers yet—nor does anyone else. The reason we call it to your attention is that you may have a problem that won't wait until we can

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MAY 1960 | VOL. 51, NO. 5

Materials in Design Engineering

FORMERLY MATERIALS & METHODS

SELECTION & USE OF METALS, NONMETALLICS, FORMS, FINISHES

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What's New in Materials

At a Glance 5

New Fluorocarbon Plastic Will Mold Readily 9
Heat, chemical resistance similar to chlorinated polyether's

What's New in Premix Molding? 12
Quick look at a low cost method for making housings, insulators

Aluminum Casting Alloys with Less Shrinkage 15
They make possible more uniform pressure-tight castings

Soft Solder Preforms Vacuum Cast for High Purity 15
Lead-tin disks, pellets offer consistent flow characteristics

Three New Copper Alloys with High Conductivity 16
Based on oxygen-free copper, they have higher softening points

Other Contents 20

Engineering & Design

At a Glance 121

A Guide to Potting and Encapsulation Materials 123
Rundown of seven principal materials and their properties

Determine Minimum Bend Radii from Standard Tensile Test 128
Two simple formulas require only reduction of area values

Selecting Aluminum Alloys for Process Equipment 130
How to look at the alloys, corrosion factors, and costs

Tensile and Impact Strengths of Ten Epoxy Adhesives 136
A report on commercial formulations —65 to 160 F

Other Contents 138

SPECIAL REPORT NO. 170

Cut Costs, Improve Quality by Better Materials Selection 139
Highlights of the 16 winning entries in M/DE competition

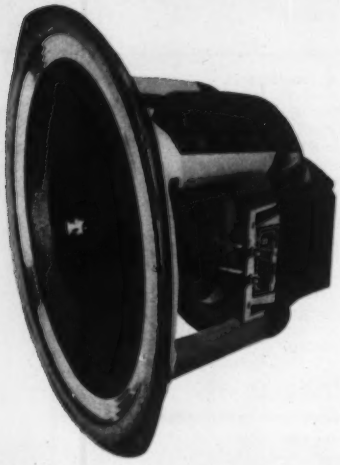
Materials at Work

At a Glance 167

Six Uses of Friction Materials 169
Transmissions, other parts show varied service conditions

CONTINUED ON PAGE 3 →

IT'S LIGHTER THAN YOU THINK!



IMPROVES ACOUSTICS and CUTS ASSEMBLY COSTS WHEN DIE CAST with ZAMAK

This zinc die cast "basket" for the UNIVERSITY Model 312 Diffaxial 3-way High-Fidelity Speaker provides the improved design and production economies necessary for outstanding performance characteristics and moderate price of this newly designed speaker, made by University Loudspeakers, Inc.

Formerly an assembly of steel stampings, this one-piece design contains supports, flanges, slots, ribs, holes, studs and channels for permanent centering and mounting of the cone, magnet pot assembly and other components. Expensive spinning and other machining operations are eliminated and final speaker assembly requires fewer steps, resulting in significant production economies.

First prize winner in our "Lighter Than You Think" die casting contest, this frame weighs only 2 lbs. 12 oz. and measures 13" across corners. It is 4⅜" deep and has a minimum wall thickness of .040". The thin-wall, hollow struts are designed to offer minimum sound reflecting surfaces while providing the extreme rigidity required for mechanical stability of the entire structure. There is no loss of magnetic energy in this speaker since zinc is non-magnetic.

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Materials at Work *continued from page 1*

Rudder Bearing Made of Phenolic Laminate 170
Large bearing is used on nuclear ship Savannah

Three Prize-Winning Zinc Die Castings 171
Hi-fi speaker basket is rigid but light in weight

Stainless Tubing Carries Sodium Coolant 171
Heat exchanger tubes bent to allow for expansion

Other Contents 171

Prices & Supply

At a Glance 27

News of Industry

World Powder Metallurgists to Meet in U. S. 29
ASTM Committees Report on Materials 29
Superalloys Discussed by SAMPE 31
Special Courses on Engineering Materials 204
News of Societies 31
Coming Meetings 33

Reader Service

..... 47

Technical Literature

Suppliers' New Literature 49
Books 196
Reports 201

Preview: Design Engineering Show and Conference 57
Program, exhibitors for meeting in New York

File Facts

Immersion Coatings 165

The Last Word

How Do We Break Through Materials Barrier? 284

Other Departments

Letters to the Editor 22
Indexes: Advertised Products 55
Advertisers 282

NEXT MONTH

Appliances: What Materials Are Next?
Guide to Potting and Encapsulating Materials (Part 2)
The High Temperature Problem:
- *Introduction to High Temperature Materials*
- *Rhenium Finds Uses in Welding, Pyrometry, Contacts, Electron Tubes*
- *High Temperature Plastics: Where Do We Stand?*
- *Four Advanced Power Generators Pose Hot Materials Problems*

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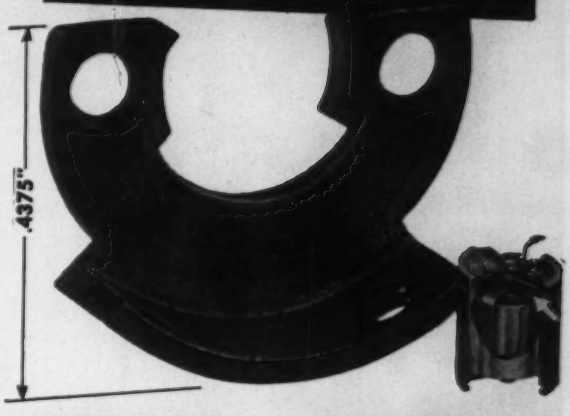

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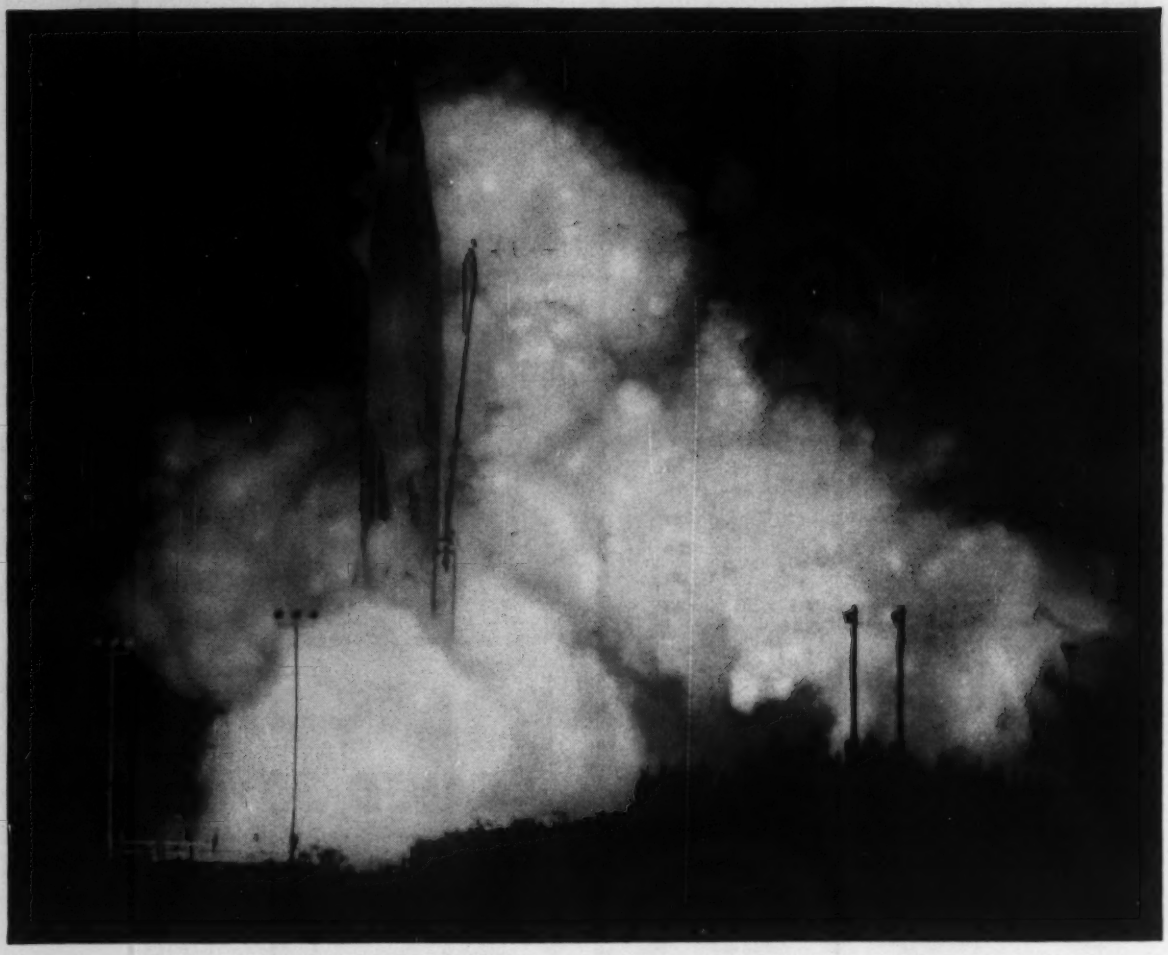

Record breaking Atlas missile billows flame and vapor as she launches 4¼-ton satellite into orbit. Constructed of Type 301 Nickel Stainless Steel, Atlas is built by Convair (Astronautics) Division of General Dynamics Corporation. *U.S. Air Force photo*

130 tons of missile with a skin thinner than a window pane!

The Nickel Stainless Steel skin of the Atlas missile is actually about one-third as thick as the glass in your window.

And yet look what this skin does:

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. . . And it is less than 1/25 of an inch thick!

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What's your metal problem? Is it high or low temperatures? Corrosion, stress, fatigue or an unusual combination of factors? Write to us about it. Perhaps Nickel—or one of its alloys—can help you get it off the ground.

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NICKEL MAKES STEEL PERFORM BETTER LONGER

What's New IN MATERIALS

...AT A GLANCE

A new polyurethane-base coating insulates at 6000 F. Key to the coating's effectiveness is "intumescence," i.e., it foams and swells when exposed to flame. The exposed surface of the coating forms a hard, ceramic-like crust that reflects heat. As the crust ablates away the process of intumescence is repeated until the crust reaches the substrate. Likely market price: $100 per gal.
Source: Dyna-Therm Chemical Corp., 5813 Hoke St., Culver City, Calif.

Pure beryllium tubing is now available in sizes from 0.250 to 2 in. o.d. It is produced from sintered billets by the hot extrusion method.
Source: Superior Tube Co., Norristown, Pa.

A conductive gasketing material for –65 to 500 F service is available in the form of sheets, gaskets, seals, shims and rings. The material is a silicone rubber compound reinforced with aluminum mesh. It is said to permit flow of electrical current between two metal surfaces while restricting the flow of any induced radio frequency. Potential uses: x-ray equipment and ignition harnesses.
Source: Auburn Mfg. Co., 20 Stack St., Middletown, Conn.

A high strength, ductile nickel bronze has been developed. It is currently available in round rod and wire only. Biggest use for the material is expected to be electrical parts such as switchgear, wire connectors and pole line hardware.
Source: Bridgeport Brass Co., 30 Grand St., Bridgeport 2, Conn.

Anodized aluminum parts with long-lasting color are promised with a new anodizing process. Reason: the color is produced by reacting alloying elements in the metal with the anodizing solution. In conventional anodizing, color is imparted by organic dyes in the solution. According to the developer, colored aluminum produced by the new process showed no perceptible fading or corrosion after exposure to salt spray for 15,000 hr, fog for 7,000 hr, and high density ultraviolet rays for more than three years.
Source: Kaiser Aluminum & Chemical Sales, Inc., 300 Lakeside Dr., Oakland 12, Calif.

The latest electromachining technique does not cause hydrogen embrittlement in steel as do conventional chemical milling techniques. The new process subjects metal to electrolytic attack in an acid solution. An oxide film forms on the surface of the metal and dissolves as rapidly as it is formed, so that metal removal is continuous.
Source: A. Watson, Cleveland Pneumatic Tool Co., 3781 E. 77th St., Cleveland 5.

A ceramic tooling material for use at 3000 F is commercially available. According to the developer, the material is readily molded using a slip casting technique in plastics molds. Potential uses: brazing and welding fixtures, hot forming dies, sintering boats, and encapsulation of resistance heating elements.
Source: Duramic Products, Inc., 426 Commercial Ave., Palisades Park, N. J.

Pure nickel dies and other shapes are being made by a nickel deposition method described in the Apr '59 issue of this magazine (p 3). A metal or nonmetallic master

Another new development using

B.F.Goodrich Chemical *raw materials*

Line of Pendent SAFE switches with housing of Hycar are manufactured by Joy Manufacturing Company, Electrical Products Division, St. Louis, and distributed by Graybar. Switches are available in 2- 4- and 6-button models with choice of lettered legends. B.F.Goodrich Chemical Company supplies the Hycar nitrile rubber.

For extra safe, improved operation

New pendent switch is encased in Hycar rubber

This new pendent switch is designed for use on hoists and other devices where suspended or portable switches are required. It is encased in a housing made from tough, resilient Hycar nitrile rubber.

Because Hycar permits such accurate molding, "O" ring seals are molded right in to make the switch watertight. Like any product made of Hycar, this housing is unusually resistant to oils, greases, acids and other corrosives. Unlike other materials tested, Hycar will not harden or stiffen at low temperatures. Pushbutton diaphragms stay flexible.

Another important advantage to the design of these switches is the resilience provided by the covering which protects the switch from damage even if it hits a hard object.

Here's another example of how Hycar nitrile rubber is improving products and opening new markets. For further information, write Dept. FN-3, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

Hycar

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mold is sprayed with a low melting compound to a thickness of ½ in. The resulting low melting negative is placed in a chamber containing carbon dioxide and heated in the presence of nickel carbonyl gas. The gas decomposes into free nickel which deposits on the negative, reproducing the original master mold in every dimension and detail.

Source: Budd Co., Carbonyl Metal Products Div., 2450 Hunting Park Ave., Philadelphia 32.

New semiconductors have been found within a number of classes of intermetallic compounds. They are selenides of lanthanum, erbium and yttrium, and tellurides of gadolinium, lanthanum, erbium and yttrium. Tests to date show all the compounds have high melting points (2500-3600 F) and good thermal stability.

Source: J. F. Miller, et al., Battelle Memorial Inst., 505 King Ave., Columbus 1, Ohio.

Ductile columbium ingots are being produced by a new method, details of which have not been revealed. According to the developer, the ingots can be shaped into solid rod or drawn into tubes.

Source: Wah Chang Corp., 233 Broadway, New York 7.

A new tantalum-shielded gasket can be used in highly corrosive atmospheres at temperatures up to 700 F, and at pressures up to 1000 psi. Two tantalum shields 0.020 in. thick are welded together at the i.d. to form an envelope. Within the envelope is a layer of corrugated steel sandwiched between two layers of asbestos to form a compressible center.

Source: Pfaudler Co., Div. of Pfaudler Permutit Inc., 1111 West Ave., Rochester, N. Y.

Die castings made of 99.99% pure aluminum are being turned out by a new technique on which no details are available. Anodizing is said to give the die castings a permanently lustrous finish with reflectivity exceeding that of chromium-plated parts. Potential uses: hardware, appliance trim, plumbing fixtures, jewelry and giftware.

Source: Fromson Orban Co., 261 Madison Ave., New York 16.

Aluminum powder metallurgy impact extrusions are expected on the market shortly. The new extrusions are said to have high strength and good heat resistance. Details as to how the parts are made have not been revealed.

Source: Aluminum Co. of America, 1501 Alcoa Bldg., Pittsburgh 19.

Polyethylene film with excellent weather resistance can be obtained with a new formulation that incorporates a non-pigment type of ultraviolet inhibiter. In weathering tests recently completed, a 5-mil thick film extruded from the resin retained a high degree of its original clarity, and remained smooth, pliable and tough, after two years of outdoor weathering.

Source: Eastman Chemical Products, Inc., 260 Madison Ave., New York 16.

Continuous welds in materials as thin as 0.00025 in. can be obtained with a new ultrasonic rotary welder. The device can also be used to weld continuous seams in materials as thick as 0.006 in. It is particularly useful in making welds where heat must be avoided. Welding speed varies from 400 fpm for thin-gage material to 8 fpm for thicker material. The welder sells for $3850.

Source: Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J.

Turn to page 9 for more "What's New in Materials"

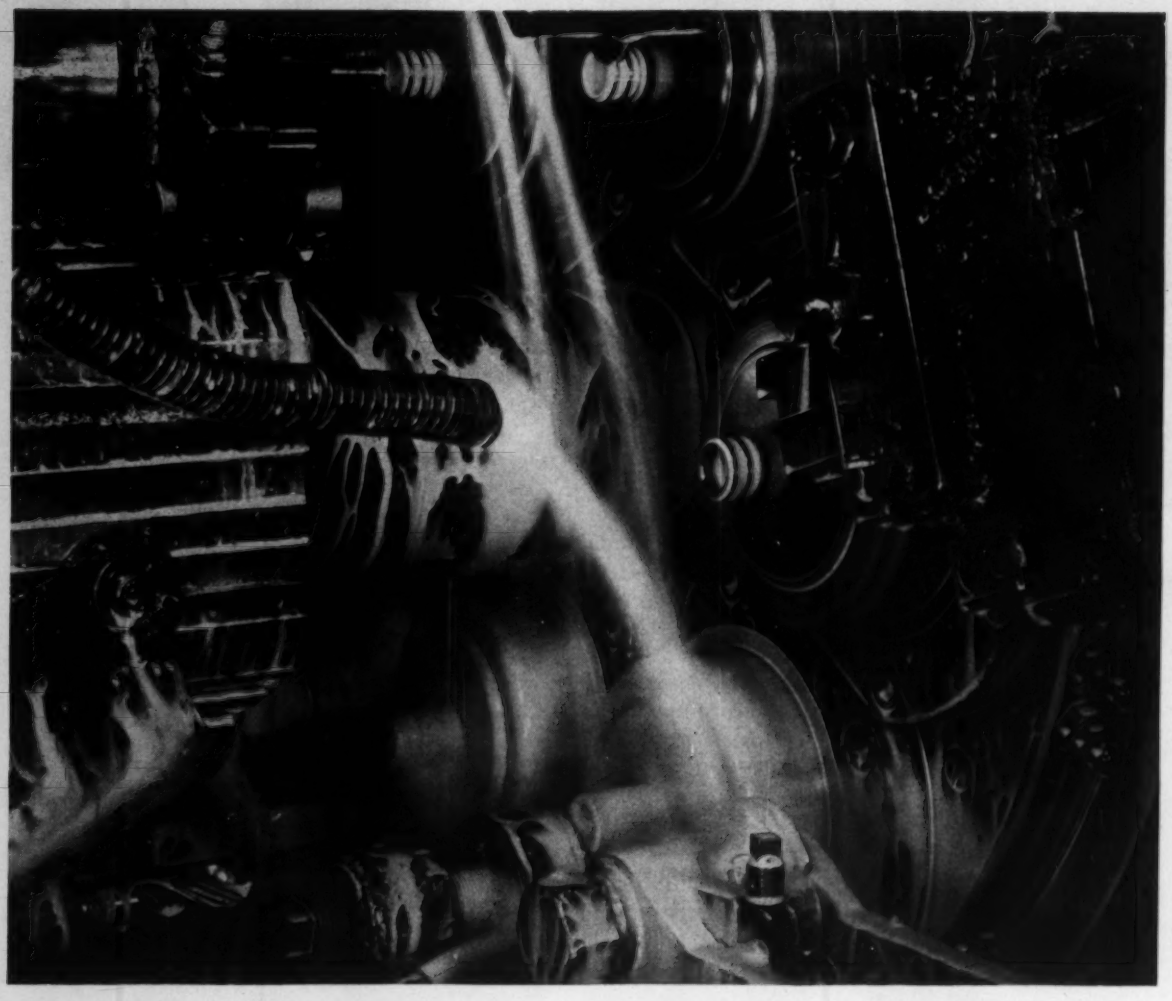
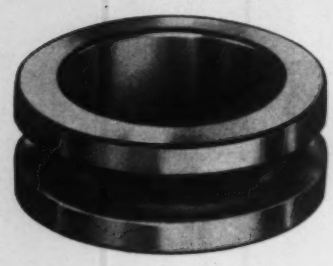


Photo courtesy SKF Industries, Inc.



SKF ... another bearing manufacturer specifies Electric Furnace quality

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***Typical forms** in which new resin can be fabricated.*

New Fluorocarbon Plastic Will Mold Readily

Polyvinylidene fluoride expected to be competitive with chlorinated polyether

by Malcolm W. Riley, *Associate Editor, Materials in Design Engineering*

■ A new fluorocarbon resin, polyvinylidene fluoride, offers excellent resistance to weathering, chemicals and heat, combined with good mechanical strength. And it can be molded by conventional thermoplastic forming techniques. Although the resin is not yet commercially available, its properties and processing characteristics have been revealed by the developer, Pennsalt Chemicals Corp., 3 Penn Center, Philadelphia 2.

Applications foreseen by Pennsalt include components for chemical and food processing equipment, protective coatings, packaging film, and electrical insulation.

Physical properties

From the property standpoint, the material appears to fall between the most recent polyolefins (high density polyethylene and polypropylene) and the older TFE and CFE fluorocarbons. Chemically similar to polyvinyl fluoride film (Du Pont's Type R film), it has the same excellent weatherability. Although it is too early to make definitive comparisons, the material appears to be most similar in properties to chlorinated polyether (Hercules' Penton) — particularly in resistance to heat and chemicals.

The table given on p 11 lists typical properties of the new material, designated RC-2525, in comparison with those of chlorinated polyether. Although price of the new material has not been determined as yet, informed estimates put it in the neighborhood of $3 per lb, roughly comparable (when considering differences in density) with that of chlorinated polyether ($3.50 per lb as of last month).

Several properties of RC-2525 can be altered by controlling crystallinity through thermal treatment. Annealing at 275 F decreases clarity, increases tensile and flexural moduli, decreases creep, increases density, relieves internal strains, and improves dimensional stability. Quick quenching reverses these effects and is normally used where clarity and flexibility are required, as in thin film and tubing.

Effects of heat and cold—The material's useful temperature range is broad, extending from —80 to above 300 F. No evidence of crazing or rupture is apparent when 1/16-in. thick sheets of the material are bent around a ⅛-in. mandrel at —80 F. Although stiffness increases sharply at extremely low temperatures, the material retains an unnotched Izod impact strength of 3.2 ft-lb per in. at cryogenic (—300 F) temperatures.

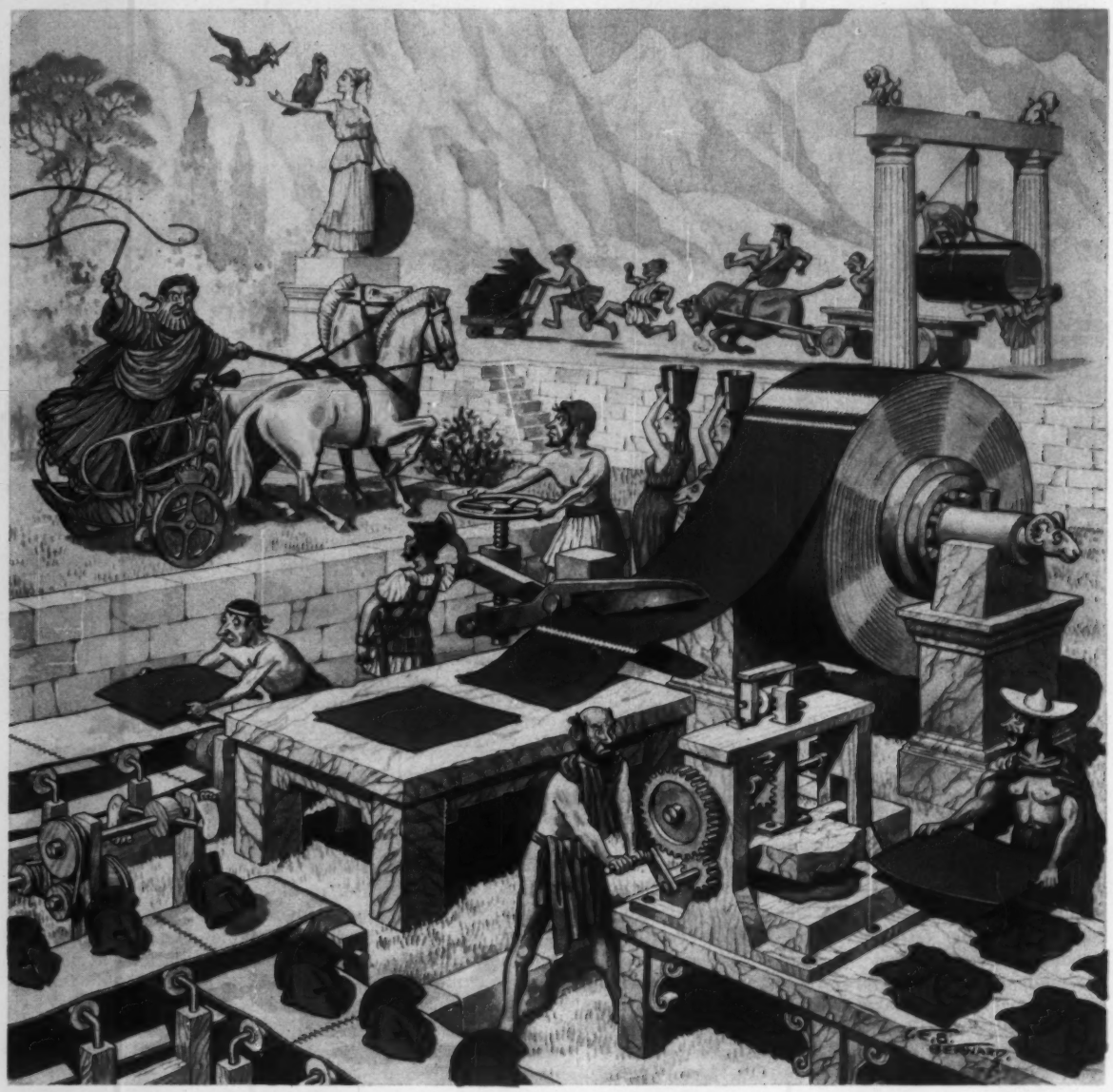
The material's crystalline nature is evident from the relatively wide gap between the 66 and 264 psi heat distortion temperatures. The resin has a crystalline melting point at 340 F; however, it is thermally stable (i.e., there is little polymer degradation) at 650 F for about ½ hr, at 500 F for about 16 hr, and at 300 F for about one year.

Electrical properties—Electrical properties of the material are not outstanding. Dielectric constant and dissipation factor are both high. Dielectric strength is relatively low in ⅛-in. specimens; in thin 0.008-in. films it improves to 1280 v per mil. The material may be suitable for thin-wall primary

Now it can be told

This engraved marble tablet recently uncovered in one of the long-lost Phrygian caves shows how Midas fooled the public. This stuff wasn't 14-karat at all. The "Midas Touch" is nothing but a myth. Midas used ColorRold* Stainless Steel, developed by Washington Steel Corporation. Gotta give the old charlatan a lot of credit though—he knew a good thing when he saw it.

MIDAS SPECS: 2 cubits × .025″ ± .001″ × coil, Type CCCII (302), Rb 82 max. Sunbrite gold, 50 glossimeter, 1 mil, paper interleaved, skidded for open oxcart only. 12 × 10^6 drachma max. wt. per coil.



*ColorRold, an organic coated stainless steel, comes in eleven harmonizing colors, can be formed and drawn or textured and highlighted in an infinite number of designs and effects, now available for your architectural or product needs.

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insulation and jacketing for specialty hook-up and control wire, and motor windings. Its high dissipation factor and resulting power losses may limit its electrical insulating uses to high frequency circuits.

Environmental properties

Comparative tests of ultraviolet resistance indicate that only the highly fluorinated TFE and CFE fluorocarbons can match the new material in stability. Fold endurance tests (M.I.T. method) on 0.002-in. film with an 0.5-kg load showed 500,000 cycles to failure for unexposed film; 450,000 cycles to failure after three months exposure to GE S-1 lamp (ASTM D795).

This resistance to ultraviolet exposure, coupled with low moisture absorption and high chemical resistance, provides excellent weather resistance. Exposing thin film for one year in an industrial atmosphere has been shown to cause an increase in tensile strength from 6500 psi to 6800 psi, an increase in yield strength from 6000 psi to 6500 psi, and a decrease in elongation from 220% to 190%.

The material is resistant to attack or penetration by most corrosive chemicals and organic solvents, including mineral acids, oxidants, alkalis, halogens and hydrocarbons. Strongly polar solvents such as dimethyl-acetamide tend to dissolve the polymer. Certain strongly basic primary amines such as n-butylamine react with the resin to form dark brittle products.

The chemical resistance of the material is one of its most important properties. Although the resin is competitive with chlorinated polyether in that both have exceptionally high chemical resistance, the two materials differ in the types of reagents they withstand. Materials suppliers should be consulted for specific recommendations based on type and concentration of reagents, and conditions of exposure.

Processing characteristics

The material will probably be available as powder or pellets for molding or extrusion, and as dispersions for coatings. According to Pennsalt, the material can be readily molded by compression or injection techniques, or extruded into shapes, rod, tubing, sheet, wire coating and cable jacketing. Conventional polyethylene screw design has proved satisfactory.

In the form of dispersions, the material can be handled somewhat like plastisols. Presence of latent solvents permits formation of continuous films at temperatures lower than the polymer's crystalline melting point. However, optimum strength films are obtained only after complete fusion at 370-420 F. Dispersions can be applied by spraying, casting or dipping in thicknesses ranging from 0.008 to 0.010 in. in one pass.

The resin can be filled with coloring pigments or other materials by dry blending. It can be readily hot welded, heat sealed, and machined. It can be bonded to itself or to other materials without pretreatment by using epoxy or epoxy-polyamide adhesives.

Applications

Primary applications for the material are expected to make use of the key combination of toughness and strength, chemical resistance, weatherability and thermal stability. Uses should include seals and gaskets; valve and pump parts; translucent tubing; heavy-wall unsupported pipe and fittings; linings for pipe, fittings, valves and pumps; and tank and autoclave linings or coatings.

In packaging applications, the material should find uses as coatings and liners for drums and other containers; as a tough, glossy film for packaging and hermetically sealing chemicals, lubricants and propellants; and as sterilizable packaging for food, pharmaceuticals and medical instruments.

The resin should also be useful as film laminated to metals, wood and other plastics to provide protection from weather and chemicals; as extruded jackets and prime insulation for high temperature wire; as coatings and saturants for fabrics; and as braids for tarpaulins.

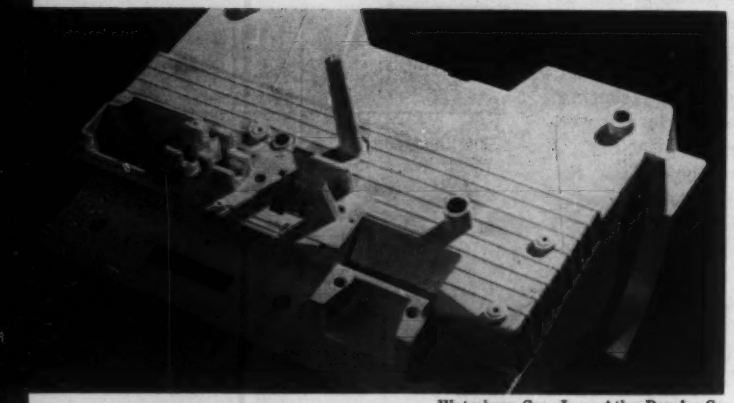
COMPARATIVE PROPERTIES OF POLYVINYLIDENE FLUORIDE

		RC-2525	Chlorinated Polyether[a]
MECHANICAL	ASTM		
Ten Str, 1000 psi			
At 77 F	D638	7	6
At 212 F	D638	5	3.5
Stress at Yld, 1000 psi			
At 77 F	D638	5.5	—
At 212 F	D638	2.5	—
Elong, %			
At 77 F	D638	300	60-160
At 212 F	D638	400	200-250
Compr Str (77 F), 1000 psi	D695	10	(8.8)[b]
Mod of Elast (77 F), 10^5 psi			
Tensile	D638	1.2	1.6
Flexural	D790	2.0	1.27
Compressive	D695	1.2	1.3
Izod Impact Str (77 F), ft-lb/in.			
Notched	D256	3	0.4
Unnotched	D256	30	>33
Hardness (Shore)		D80	(R100)[c]
PHYSICAL			
Heat Dist Temp, F			
66 Psi	D648	300	300
264 Psi	D648	195	185
Ther Cond, Btu/hr/sq ft/°F/in.		1.05	—
Coef of Ther Exp, 10^{-5} per °F	D696	8.5	4.4
Water Absorp (24 hr), %	D570	0.04	0.01
Spec Gr	D792	1.76	1.4
Spec Vol, cu in./lb		15.7	19.8
Refrac Index, n_D^{25}	D542	1.42	—
Flammability	D635	Self-ext	Self-ext
ELECTRICAL			
Vol Res, ohm-cm	D257	2×10^{14}	5×10^{15}
Dielec Const			
60 Cps	D150	8.4	3.1
10^6 Cps	D150	6.6	2.8
Dissip Factor			
60 Cps		0.049	0.016
10^3 Cps		0.018	0.008
10^6 Cps		0.17	0.01
Dielec Str (short time), v/mil			
½-In. Specimen	D149	260	400
Thin Film	D149	1280[d]	4000[e]
FABRICATING			
Molding Temp, F		400-550	440-465
Mold Shrink, in./in.		0.020	0.005

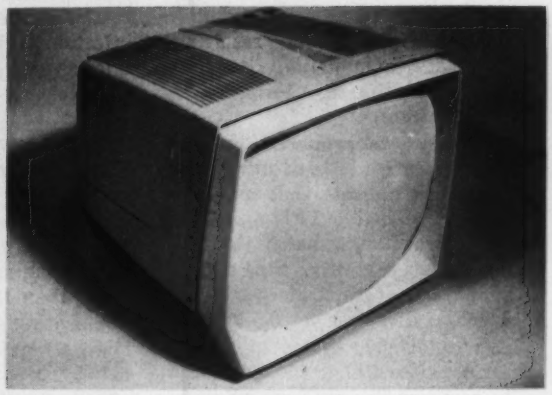
[a]Typical properties of Hercules' Penton.
[b]Compressive stress at 1% offset.
[c]Rockwell R scale.
[d]0.008-in. film. [e]0.002-in. film.

For more information, circle No. 600

SIX WAYS TO USE PREMIX...



Waterbury Cos., Inc.; Atlas Powder Co.



Owens-Corning Fiberglas Corp.

HOUSINGS . . .

***Film splicer housing**—Durability at low cost resulted from switch to glass-premix from zinc die casting for this intricate housing.*

***Portable TV housing**—Structural strength at low cost resulted from use of high performance glass-premix.*

What's New in Premix Molding?

Five years have brought many new materials—along with some design problems.

by Malcolm W. Riley, *Associate Editor, Materials in Design Engineering*

■ Five years ago premix compounds meant low cost, low strength polyester molding compounds reinforced with sisal or sisal-glass fibers. Nickname: "gunk."

Today premix compounds mean a variety of materials providing a wide range of mechanical, electrical and chemical properties.

With improvements, of course, have come problems. The end user cannot simply select a premix compound on the basis of standard engineering property data. The final properties of a molding and the quality of the molding are highly dependent on variables involved in compound formulation, mold design and molding technique.

These variables can be altered and controlled properly by competent molders to produce a highly satisfactory part. But the end user must work closely with the molder, both in selecting the grade, and in designing the part to ensure optimum results. In many cases, final materials selection can only be based on trial-and-error sampling of compounds.

The classification of compounds used here should not be regarded as a rigid one, as many different compounds are custom-premixed by molders for specific uses.

Low cost grades

Grouped here are the low cost (12-15¢ per lb) sisal-reinforced, sisal-glass-reinforced, and low glass content (about 15%) compounds. Properties are shown in the accompanying table. This group represents the oldest type of premix and has not changed noticeably (see *Materials & Methods*, Sept '55, p 104). The materials are still widely used for noncritical, low stress parts. Sisal reinforcement provides good moldability, but also low strength and a relatively high moisture absorption of 1.3-2.3% in 24 hr. Addition of small amounts of glass improves moisture absorption and strength to some degree.

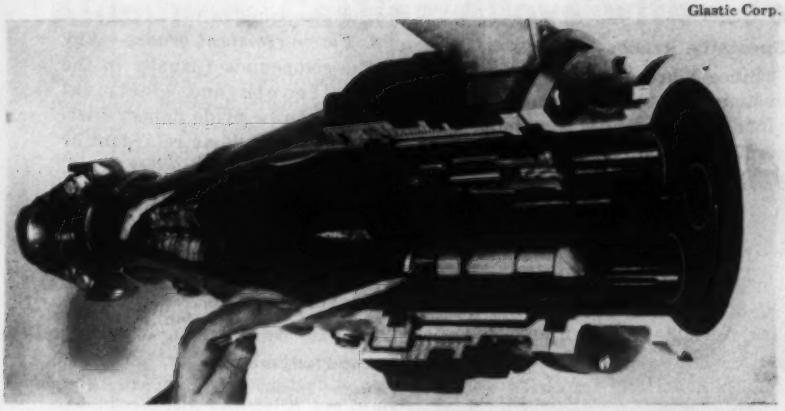
High performance compounds

Much of the activity in premix has been centered in the development of high performance or high strength grades. These usually contain about 25-30% glass. However, lower glass contents together with various types and proportions of fillers are also used to alter performance and cost. High glass compounds may cost about 40-60¢ per lb; lower glass compounds may range down to 25-40¢ per lb.

The table lists ranges of properties for high glass compounds and for high filler compounds. The ranges are admittedly wide, but lack of correlation between test results on standard specimens and specimens cut from moldings make a more detailed breakdown somewhat meaningless, and possibly misleading.

The trick in producing a high glass compound is to get the highest possible glass content, while still providing good flow and mold-

Glastic Corp.

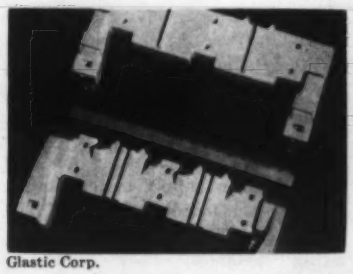


Firmaline Products, Inc.

ELECTRICAL INSULATION . . .

Cable coupler—*Lower cost, and improved resistance to impact and arc tracking were achieved by switching to premix from cast epoxy in this 7.5-kv cable coupler (shown with housing partly cut away).*

Circuit breaker bushing, cap and adapter—*Longer life and improved electrical properties were obtained with a specially formulated glass-premix. It replaced phenolic in these components molded for Federal Pacific Electric Co.*



Glastic Corp.

Owens-Corning Fiberglas Corp.

TOUGH PARTS . . .

Contact supports—*Impact strength required to resist the shock of powerful solenoids is provided by premix in these front stationary contact supports for Allen-Bradley's new air-break contactor. Replacing machined laminate, premix cut cost 50%.*

Coupling seal—*Chemical resistance as well as toughness were provided by premix used for this seal for chemical process equipment.*

INDICATIVE PROPERTIES OF PREMIX COMPOUNDS

Property	ASTM Method	Low Cost[a]	High Performance	
			Intermediate Strength[b]	High Strength[c]
Izod Impact Strength, ft-lb/in. notch	D256	1-5	4-7	12-24
Flexural Strength, 1000 psi	D790	4-9	6-17	11-25
Flexural Modulus of Elasticity, 10^5 psi	D790	6-9	7-11	16-20
Rockwell Hardness	D785	M35-60	—	M98-100
Heat Distortion Temperature (264 psi), F	D648	200-350	200-350	300-550
Water Absorption (24 hr), %	D570	0.7-2.3	0.1-0.4	0.1-0.4
Specific Gravity	D792	1.5-1.8	1.8-2.0	1.8-2.0
Mold Shrinkage, in./in.		0.004	0.001-0.004	0.001-0.004
Cost, ¢/cu in.[d]		0.7-1.0	1.6-2.9	2.6-4.3

[a]Range covered by sisal, sisal-glass, and low glass content.
[b]Range generally provided by glass contents of 15-20%, and various filler loadings.
[c]Range generally indicated for high glass (25-30%) by compound suppliers.
[d]Cost figures based on compound cost estimate of 12-15¢ per lb for low cost grades; compounders' large volume price range of 40-60¢ per lb for high-glass grades; and intermediate estimate of 25-40¢ per lb for intermediate strength types. Actual costs depend on specific compound and whether purchased or premixed.

ability, and to avoid degrading the glass fiber during mixing. Several recent developments promise improvements in this direction. For example, so-called HSI (high strand integrity) glass is said to provide easier mixing, better retention of strand integrity, and better flow, yet greater strength in the final molding. Also, according to some molders, the use of isophthalic polyester resins substantially improves moldability and impact strength.

Design problems — Unfortunately standard engineering properties, such as those in the accompanying tables, cannot be used for design. Increasing glass content of a compound increases its strength—but it also decreases moldability, making even distribution of reinforcement throughout the part more difficult. For example, Atlas Powder reports that although flexural and impact strengths of one of its compounds, based on standard ASTM specimens, are 20,000 psi and 12 ft-lb per in. notch, respectively, values obtained on specimens cut from a molded part average only 16,000 psi and 4.5 ft-lb per in. notch.

Such strength variation is due

to the ideal distribution of fibers in a molded ASTM specimen, and the difficulty in reproducing this distribution and orientation in a molding. Both materials suppliers and molders are developing ways of getting more realistic property data. At present, however, standard data should be used only as a general index to the kind of behavior a compound will provide when properly molded.

Other factors affecting strength may be 1) variables in formulating, such as excessive shearing stresses during mixing (resulting in a loss of glass integrity), or altering the type of filler used, or 2) variables in molding technique, such as the way the mold is loaded, or temperature and time of cure.

The excessive dependence of final properties on formulating and molding variables makes close cooperation between end user and molder mandatory.

Electrical compounds

Glass-reinforced premix compounds specifically designed for electrical uses are reported to have dielectric strength in the 300-400 v per mil range, volume resistivity as high as 11 x 10^{14} ohm cm, dielectric constant at 1 kc of about 5.4, and dissipation factor at 1 kc of about 0.035. Both flame resistant and nontracking compounds are available. Heat distortion temperatures (264 psi) of about 400-450 F are commonly reported.

Design problems—Probably the most common problem in getting a quality electrical molding is the presence of voids. For example, *White* points out that although a compound may have a dielectric strength of 300 v per mil when tested on a standard ASTM specimen, dielectric strength of the same compound molded in a 9/16-in. section may be only 62 v per mil. Voids are more apt to occur generally in thicker sections with higher glass contents.

One solution is to reduce glass content in the trouble area, using a higher filler content. Highly filled materials are less prone to void formation. Although lowering glass content decreases strength, the section can often be increased to compensate for this strength loss.

Specialty grades

Since a great deal of premix is custom formulated, there are obviously many grades that could be termed "specialty." Here are some of the more common types:

1. Chemical resistant grades—Although conventional polyester resins generally contribute good chemical resistance to premix compounds, many specialty compounds are formulated with polyesters such as the bisphenol type which has substantially improved chemical resistance.

2. Nylon-reinforced grades—Nylon reinforcements are used primarily to provide good surface characteristics. Strengths are not as high as those of glass-reinforced compounds.

3. Flame resistant grades—Any of the compounds (usually in the high strength and electrical grades) can be made flame resistant by use of a flame retardant or a flame resistant polyester resin.

References

Campbell, J. B., "Premix Plastics Moldings for Low Cost Parts," *Materials & Methods*, Sept '55, p 104.

White, R. B. and Jackson, R. S., "Problems With Premix Moldings, Parts 1-4", *Modern Plastics*, Mar, May, July, Sept '59.

Acknowledgments

Particular thanks are due R. Doyne, S. Feuer, and W. Scott of Atlas Powder Co., and S. Sikes of Owens-Corning Fiberglas Corp. for their assistance; also personnel and literature of the following companies:

Glastic Corp.
Plumb Chemical Corp.
Plymouth Cordage Co.
Woodall Industries, Inc.

Buyer's Guide to Premix Compounds

Essentially premix compounds are the polyester counterparts of fiber-reinforced phenolic, melamine or urea compression or transfer molding compounds. The term "premix" was originally used because the first such compounds were mixed by molders in their own shop prior to molding. Although today's compounds are both "premixed" by molders and supplied by compounders the term has stuck.

Some companies have attempted to market phenolic resins in a form suitable for premixing by the molder into compounds, but reception has been limited. Economies of this approach do not appear to be as large as those obtainable with polyesters.

Who is the supplier?

The end user first considering premix materials may well wonder just who his materials supplier is. This confusion stems from the controversy between compound suppliers and premixing molders. This is the situation at present:

1. Virtually all the low cost grades are premixed by custom or captive molders.

2. The high strength, electrical and specialty grades are both supplied by compounders and premixed by molders.

Compound suppliers argue that they can supply materials of consistent quality by maintaining close control over formulating variables. They argue that their initial higher materials costs are usually more than offset by the user's saving in capital investment for mixing equipment and formulating know-how required to maintain comparable quality in a molder's mixing operation. And finally, they emphasize that their forte is quality, and that where quality is not required a competent molder's premix should be used.

Proponents of premixing by the molders claim lower raw materials costs, flexibility of formulation from a relatively narrow inventory, and close control over the compounds.

Molder is key

Essentially, an end user doesn't care who mixes the compound; what he wants is performance. By contacting a competent molder and working with him on the design of the part, he can get optimum performance at lowest cost, whoever supplies the compound.

For more information, circle No. 601

Aluminum Casting Alloys with Less Shrinkage

■ A new grade of aluminum casting alloys, in which shrinkage tendencies are substantially reduced and controlled, has been developed by American Smelting and Refining Co., 120 Broadway, New York 5.

The controlled shrinkage is attributed to unspecified improvements in the refining process. According to AS&R, these improvements do not affect physical or mechanical properties, machinability, castability, fluidity, or heat treating response.

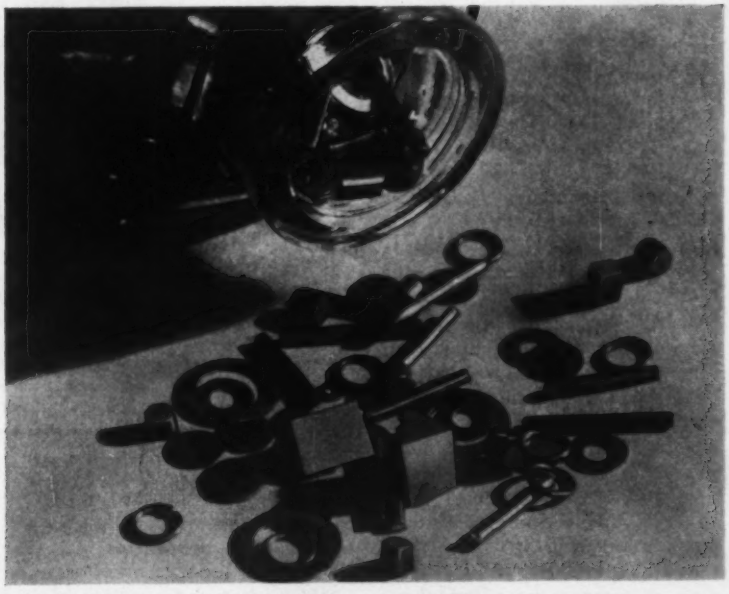
The PT (for pressure-tight) grades are available as alternatives to any of the standard sand and permanent mold aluminum casting alloys, but not for die casting alloys. The PT grades are said to reduce the variable and unpredictable shrinkage commonly encountered in aluminum foundry work and thus eliminate the need for extra gates and risers.

The unusual degree of casting control possible with PT alloys results in more uniform pressure-tight castings. In addition, AS&R says, the castings have a brighter, cleaner surface because of the reduction in surface shrinkage.

For more information, circle No. 605

Casting *at right (PT 319 alloy) is free from porosity. Same shape cast in standard 319 alloy shows shrinkage at surface (circled).*

Soft Solder Preforms Vacuum Cast for High Purity



Preforms *of soft solder made by vacuum casting.*

■ Using vacuum casting techniques, Accurate Specialties Co., 37-11 57th St., Woodside 77, N. Y. is manufacturing solder preforms with a purity of 99.99%.

Soft solder alloys produced in the past by pig casting or hot extrusion contained oxygen or oxides which tended to reduce wettability and flow characteristics and lower the yield of the finished component. Vacuum cast preforms are said to offer consistent flow characteristics.

Materials being vacuum cast range from 99.999% lead to 99.999% tin, with such intermediate lead-tin combinations as 95:5, 60:40, 50:50 and 40:60. Melting points range from 361 to 689 F.

Preforms are available as flat washers, disks and pellets. To insure continued purity the preforms are packaged in argon or other protective atmospheres.

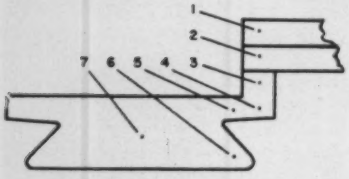
For more information, circle No. 606

Alloying high-purity, oxygen-free copper has resulted in

Three New Copper Alloys with High Conductivity

offering higher softening temperatures and improved recovery scrap

by Donald Peckner, *Associate Editor, Materials in Design Engineering*



***1** OF copper-zirconium has greater resistance to softening, allows designer more freedom in designing brazed or soldered joints. (Nippert Electric Products Co.)*

EFFECT OF BRAZING SOLID LEAD TO STUMP RISER
(Rockwell F Readings)

Alloy	Bar No.	Position of Hardness Measurement						
		1[a]	2[a]	3	4	5	6	7[b]
Copper Plus Silver (25 to 30 oz per ton)	1	55	49	50	49	56.5	96	93
	2	36	32	45	43	54	90	92
	3	52	50	49	52	52	96	94
	Avg	47.7	43.7	48	48	54.2	94	93
OF Copper Plus Zirconium	1	42	43	61	86.5	86.5	92.5	90
	2	47	47	71	87	87	92.5	91
	3	41	42	86	88.5	89	93	93
	Avg	43.3	44	72.7	87.3	87.5	92.7	91.3

[a]Lead wires, positions *1* and *2*, were electrolytic copper.
[b]Position *7* taken at center of bar using bar gage.

1. OF copper plus zirconium / *Higher Conductivity— Extended Operating Temperature*

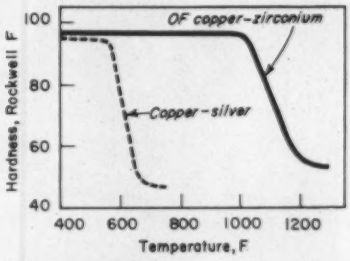
Most significant of the new alloys is OF copper plus zirconium. As operating temperatures have increased, designers have turned from pure copper to copper-silver alloys and then to copper-chromium alloys. Now copper-zirconium has further increased the temperature at which copper alloys can be used.

Copper-zirconium alloy—available in all mill forms—has a conductivity rating approximating that of copper, and retains its strength (in the cold worked condition) after long exposure at temperatures up to 750 F. For many applications it will supplant both silver-bearing copper and chromium copper because of its ability to retain strength at temperatures ranging 120 to 210 F above their maximum operating temperatures.

Copper-zirconium alloys are available under two commercial tradenames. American Metal Climax Co. refers to its alloy as Amzirc. Following its own development program, Nippert Electric Co. designated the alloy N-4.

High softening temperature

Fig 1 illustrates one of the principal advantages of OF copper-zirconium. After brazing, because of its high softening temperature, the alloy does not exhibit a substantial hardness drop near the brazed joint. Silver-bearing copper, on the other hand, shows a hardness drop (and, consequently, a loss of strength) until an area remote from the brazed joint is reached. Fig 2 further shows how the alloy retains hardness at temperatures far above the operating range of silver-bearing copper.



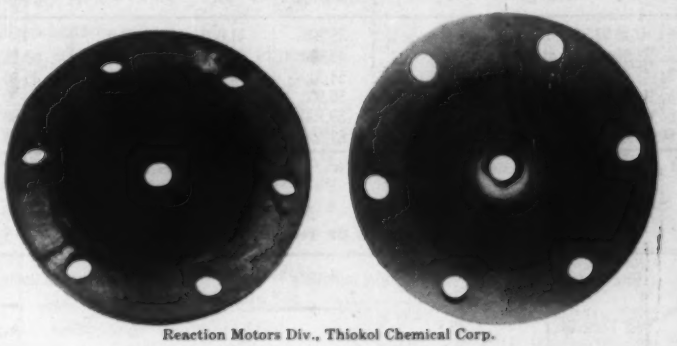
***2** OF copper-zirconium is significantly harder than copper-silver. Tests were run at room temperature after holding specimen at elevated temperature 1 hr. (Nippert Electric Products Co.)*

Mechanical properties

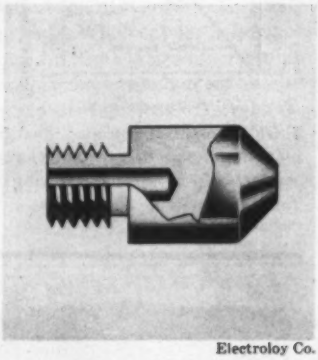
OF copper-zirconium can be cold worked and aged to obtain a

Four Uses of OF Copper-Zirconium

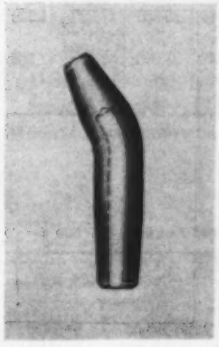
Orifice plate for catapult igniter unit—*Orifice plate is required to operate for 5000 cycles. Cycle consists of 7 sec running, 7 sec water cooling on face of orifice plate, and 16 sec rest. Igniter operating temperature is about 3500 F; orifice plate reaches 1500 F. The OF copper plate (left) was removed after 4679 cycles (orifice diameter opened up and severe heat checking developed). The OF copper-zirconium plate (right) was removed after 6941 cycles (orifice diameter opened up).*



Reaction Motors Div., Thiokol Chemical Corp.



Electroloy Co.



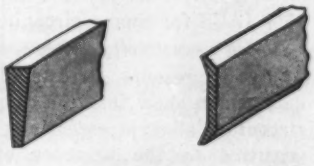
Resistance welding electrodes—*Basic requirements for resistance welding electrodes are: 1) good electrical conductivity, 2) hardness, and 3) resistance to annealing at elevated temperatures. High electrical conductivity reduces contact resistance beween workpiece and electrode, creates less heat, and minimizes electrode pickup from material being welded. Hardness and resistance to annealing reduce electrode mushrooming and wear.*

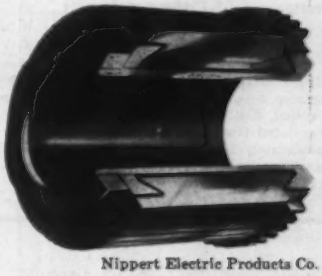
Use of OF copper-zirconium resulted in increased electrical conductivity (relative to standard electrode alloys). High softening temperature increased electrode life by a factor of two.

Nippert Electric Products Co.

Stud bases for power transistors and rectifiers—*Extruded bases (see cross section) made from OF copper-zirconium provide the designer with a material that can be brazed without appreciable loss of strength. As a result, bases can be tightened to assemblies with higher torquing load than was previously possible.*

Motor applications—*The two sections sketched here are typical of the drawn copper shapes that are being produced from OF copper-zirconium to take advantage of the alloy's high electrical conductivity and resistance to softening. Photograph shows cross section of commutator that uses notched segments made from OF copper-zirconium (segments are accented). Operating experience to date has been successful. Segments made from copper-chromium are notch sensitive and tend to crack at the dovetail base as operating stresses develop at elevated operating temperatures. Use of OF copper-zirconium provides designer with a material that can be dip soldered or brazed with no loss of strength. Alloy actually will perform satisfactorily at temperatures exceeding the operating range of commercially available insulation and lubrication.*





Nippert Electric Products Co.

TABLE 1—HOW COLD WORKING AND AGING AFFECT OF COPPER-ZIRCONIUM

Condition[a]	Ultimate Tensile Strength, psi	Yield Strength (0.1% offset), psi	Elongation (in 0.2 in.), %	Electrical Conductivity (% IACS)
Aged 1 Hr at 932 F	35,200	11,000	23.0	95
CW 21%, Aged 1 Hr at 800 F	45,500	36,600	10.5	90-95
CW 34%, Aged 1 Hr at 700 F	54,300	44,900	7.5	85-90
CW 55%, Aged 1 Hr at 700 F	56,600	47,300	7.5	85-90
CW 65%, Aged 1 Hr at 700 F	59,700	51,300	10.0	85-90
CW 90%, Aged 1 Hr at 700 F	62,500	53,200	9.5	85-90

[a]All solution annealed before cold working (CW). Source: American Metal Climax Co.

TABLE 2—TENSILE PROPERTIES OF THREE COMMUTATOR ALLOYS[a]

Direction →	Parallel to Rolling						Transverse to Rolling		
Test Temp →	75 F			550 F			550 F		
Alloy →	Silver-Bearing	Cr Copper	OF Cu +Zr	Silver-Bearing	Cr Copper	OF Cu +Zr	Silver-Bearing	Cr Copper	OF Cu +Zr
Hardness, R_B	61	82	64	(65 VHN)[b]	48[b]	22[b]	—	—	—
Ten Str, psi	50,000	71,000	53,000	35,000	50,000	42,000	36,500	47,000	44,000
Yld Str (0.2% offset), psi	47,000	64,000	50,500	28,000	46,000	40,500	31,000	41,000	42,000
Red. in Area, %	51	43	54	43	7	37	26	6	44
Elong (in 2 in.), %	8	16	10	12	4	8	8	3	6

[a]Silver-bearing copper was in cold rolled condition; other alloys were solution annealed, quenched, cold rolled and aged. [b]Hot hardness test.
Source: Nippert Electric Products Co.

TABLE 3—RUPTURE STRENGTH OF THREE COMMUTATOR ALLOYS AT 500 F[a]

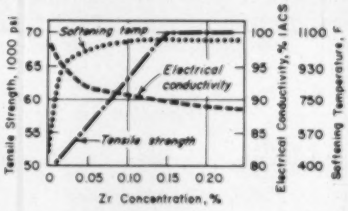
Rolling Direction	Alloy	After 100 Hours, psi		After 500 Hours, psi[b]	
		Unnotched	Notched	Unnotched	Notched
Longitudinal	OF Copper plus Zr	34,000	37,500	32,000	35,500
	Chromium Copper	36,000	28,000	32,500	23,500
	Silver-Bearing Copper	17,500	15,500	10,500	[c]
Transverse	OF Copper plus Zr	38,000	41,500	36,500	38,500
	Chromium Copper	18,500	17,000	13,000	12,000
	Silver-Bearing Copper	20,000	15,500	14,000	[d]

[a]Condition of specimens: OF copper + Zr solution annealed, quenched, cold rolled, aged, R_B64. Chromium copper solution annealed, quenched, cold rolled, aged, R_B82. Silver-bearing copper, cold rolled, R_B61.
[b]Extrapolated from tests running up to 350 hr.
[c]Approximately 10,000 psi after 210 hr and decreasing rapidly.
[d]Approximately 10,000 psi after 300 hr and decreasing rapidly.
Source: Nippert Electric Products Co.

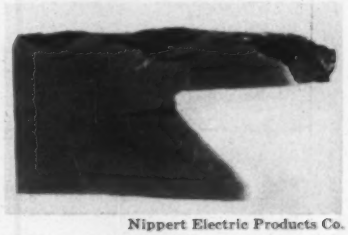
TABLE 4—CONDUCTIVITY AND MODULUS VS TEMPERATURE FOR OF COPPER-ZIRCONIUM

Temp, F	Elec Cond, % IACS	Mod of Elast, 10^6 psi
68	93.0	19.3
200	67.2	—
320	57.4	—
425	55.1	—
485	47.2	—
580	44.1	—
655	41.3	—
745	40.1	16.26
824	37.7	—
915	32.6	15.47
1030	30.6	—
1115	28.2	14.75

Source: American Metal Climax Co.



3 OF copper-zirconium has high softening temperature and electrical conductivity after cold working 80% and aging at 750 F. (American Metal Climax Co.)



Nippert Electric Products Co.

4 Copper-chromium commutator segment is notch sensitive and many fail in dovetail. No similar failures have been reported for OF copper-zirconium.

desirable combination of properties. Table 1 shows effects on a typical composition. Fig 3 shows the effect of zirconium content on properties of aged and cold worked wire.

Copper-chromium is stronger than either the copper-silver or copper-zirconium alloys at temperatures up to 550 F (see Table 2). This mechanical strength advantage is offset, however, by the significantly higher softening temperature of copper-zirconium (750 F vs 660 F) as well as the significant improvement in electrical conductivity. (Heat treated copper-chromium has a conductivity of 80% IACS as opposed to 90-95% IACS for copper-zirconium.)

Notch sensitivity improved—Table 3 presents stress-rupture data which show that the copper-zirconium alloy is essentially insensitive to the presence of a notch.

Fig 4 is a photograph of a copper-chromium commutator segment which cracked at the base of a dovetail. Experience of Nippert Electric Co. indicates that no copper-zirconium alloy commutator bars have failed in service because of cracking.

Physical properties

Table 4 shows that, as would be expected, electrical conductivity and modulus of elasticity decrease as temperature increases.

For more information, circle No. 607

2. OF copper plus phosphorus / *Higher Softening Temperatures Increased Workability*

One of the advantages claimed for this alloy, furnished as billets, is that all of the phosphorus is in solid solution in the copper. Pouring the OF copper heat in a non-oxidizing atmosphere prevents the formation of the phosphorus pentoxide (P_2O_5) usually found in phosphorus-deoxidized copper. All of the phosphorus present is available to improve working characteristics.

Softening temperature

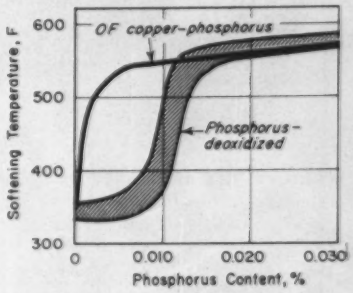
Fig 5 shows that, in comparison with phosphorus-deoxidized copper, OF copper-phosphorus resists softening at lower phosphorus contents. When copper components must be dip soldered, a maximum phosphorus content may be specified to prevent loss of strength of the soldered parts.

Workability

As shown below, hot piercing time may be reduced by careful specification of phosphorus content. The reduction in piercing time, while seemingly slight, is actually an important advantage in manufacturing situations where the unit cost rate is high.

%P	Avg Piercing Time, Sec
OF Copper + Phosphorus	
Nil	18.4
0.010	20.2
0.020	21.4
Phosphorus-Deoxidized Copper	
0.015	26.5
0.025	30.2
0.033	35.1

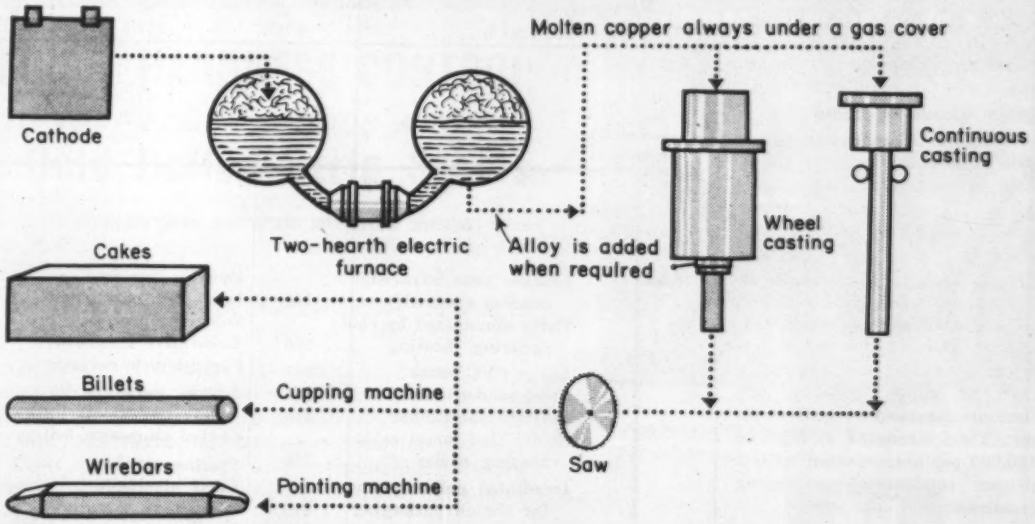
Since OF copper-phosphorus is more expensive than phosphorus-deoxidized copper, costs must be carefully calculated to determine the least expensive procedure to obtain the end product.



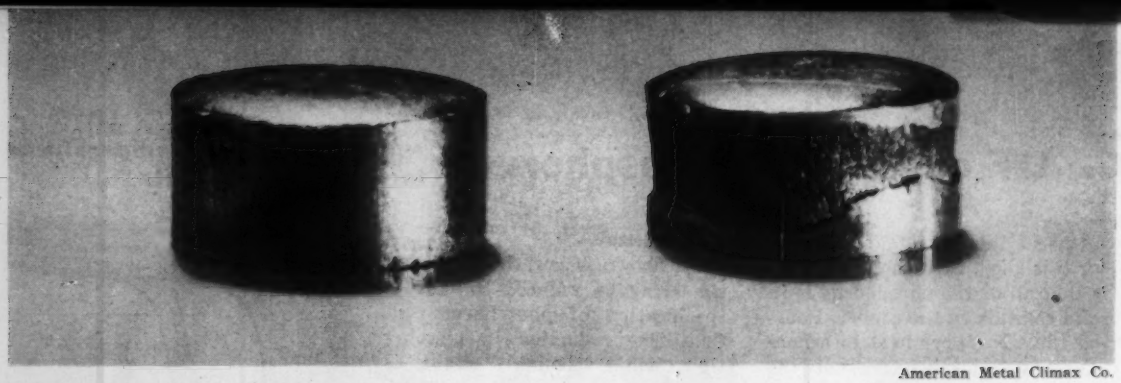
5 *Softening temperature of OF copper-phosphorus is higher at lower phosphorus content.* (American Metal Climax Co.)

For more information, circle No. 608

Three New Alloys Are Based on 'Oxygen-Free' Copper



What is OF copper? *As the flow chart indicates, OF copper is produced by the direct conversion of selected refinery cathodes into castings under conditions controlled to prevent contamination of the melt by oxygen. Melted in a protective atmosphere, the metal is then poured into molds—also under a pressurized protective atmosphere. Copper content of the castings is approximately 99.99%.* (American Metal Climax Co.)



American Metal Climax Co.

Relative lack of shear drag *of OF copper, compared to tough pitch copper (see photo) is of interest in closed die extrusion. Since the sheared OF copper breaks cleanly, the volume of the extrusion slug can be closely calculated and the number of rejected extrusions reduced.*

3. OF copper plus sulphur / *Better Scrap Price*

Two free-cutting copper-base alloys have been available for screw machine applications: copper-lead and copper-tellurium. The development of OF copper with sulfur does not offer any startling advancement in machinability. The principal advantage for those companies which refine their own copper scrap is that the sulfur can be economically removed in a fire-refining operation. Thus, the possibility of contaminating the furnace charge with lead or tellurium is eliminated.

Table 5 compares properties and prices of the three free-cutting copper alloys.

Acknowledgments

The writer would like to thank Mr. Paul Nippert, Nippert Electric Products Co., and Mr. Howard Blank, American Metal Climax Co., for the data and discussions necessary for development of this article. The cooperation of the following is appreciated:

American Metal Climax Co.
Electroloy Co.
Nippert Electric Products Corp.
Reaction Motors Div., Thiokol Chemical Corp.

TABLE 5—PROPERTIES AND SCRAP COST OF FREE-CUTTING COPPERS

Type of Copper →	OF Copper-Sulfur	Copper-Tellurium	Copper-Lead
Tensile Strength, 1000 psi	44	44	45
Yield Strength, 1000 psi	38	38	38
Elongation (in 2 in.), %	10	10	12
Hardness, Rockwell B	45	45	45
Electrical Conductivity, % IACS, min	90	90	92
Relative Machinability, %	80	80	80
Scrap Resale Value, $ per lb	0.2425	0.1775	0.2375

Where to Get Them

The three new alloys are available in mill forms from Bridgeport Brass Co. and American Brass Co. Philadelphia Bronze and Brass Co. supplies forgings.

Other alloys to come

Additional OF copper alloys are still in the development stage. Although commercial availability cannot be predicted at this time, two types of alloys to look for are:

- High strength alloys such as OF copper plus titanium and OF copper plus nickel and phosphorus. The copper-titanium alloy is a precipitation hardening material whose properties are further improved by cold working. Yield strengths as high as 180,000 psi are expected with a proper combination of aging treatment and cold work.
- An alloy with a low temperature coefficient of electrical conductivity, capable of maintaining conductivity over a broad temperature range.

For more information, circle No. 609

MORE WHAT'S NEW IN MATERIALS

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Parts aluminized by cold spraying, heating 210
Large PVC parts 212
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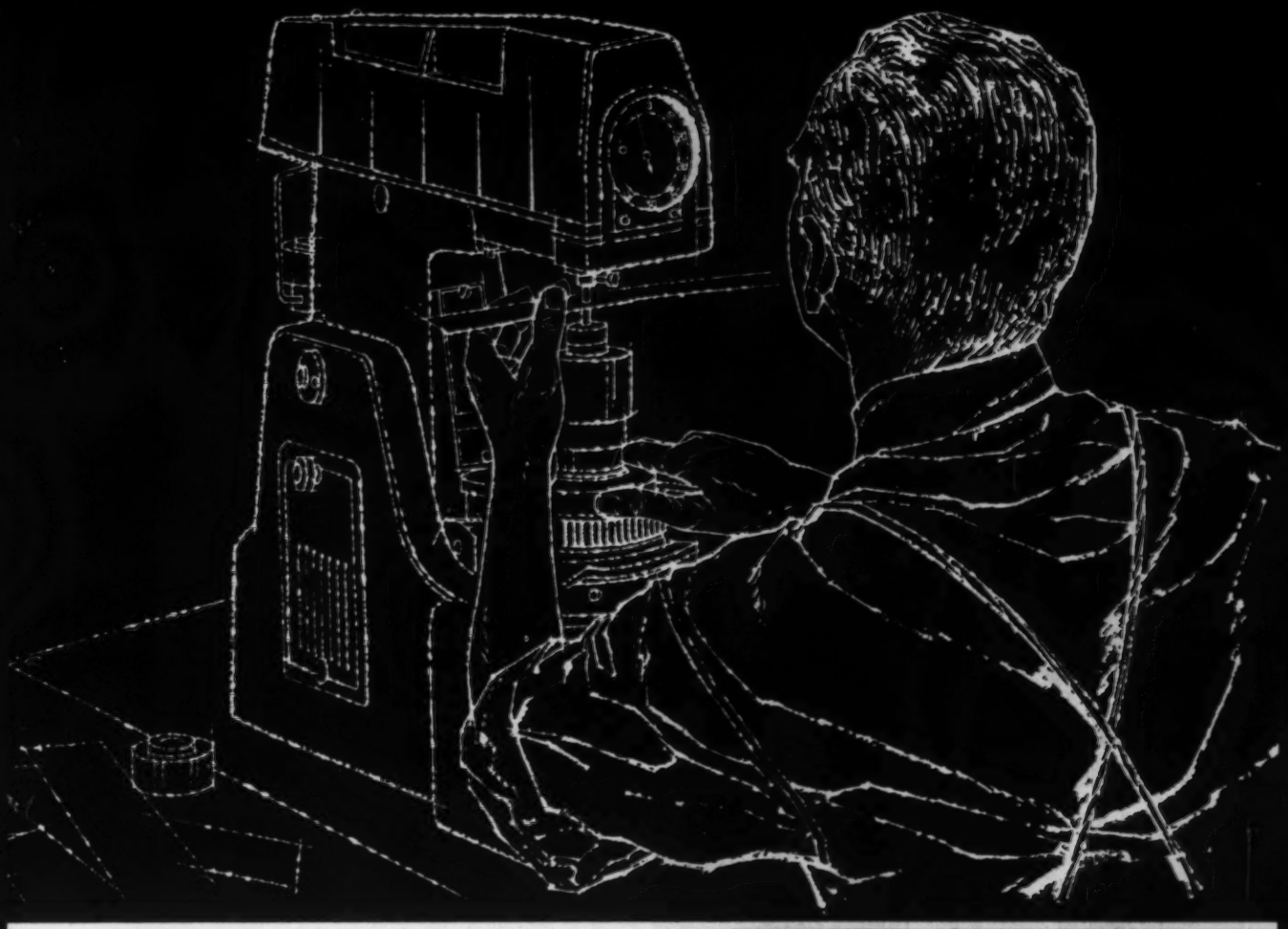
Soft silicone rubber 214
Solder-clad metal makes brazing easier 216
Irradiated polyethylene for shrink packaging .. 218
High pressure gaskets..... 222
Cold work die steel..... 224
RTV silicone compounds.. 224
Larger clad tube sheets.. 226
Solution removes oxide from aluminum 228
Epoxies for tooling..... 228
Low cost parchment..... 230
Soldering process 233
Decorative laminate 235
Ferroelectric ceramic 236
Acrylic moldings have high impact strength... 236
Coated aluminum foil 238
Plastics planks 240
Vinyl plastisols 244
Refractory material 246
Compound retards static electricity 248
Glass-base premix 248
Plastics extrusions are multicolored 252
Other news 254



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Help needed on . . . machinability of plastics

To the Editor:

We would like to obtain information on the machinability of various types of plastics.

F. GENTILE
Aero Supply Mfg. Co., Inc.
Corry, Pa.

. . . stress lines in plastics

To the Editor:

I am interested in building a device to show stress lines in prepared pieces of plastic, and would appreciate receiving any information that is available on such a device.

R. B. Fox
Dept. of Industry
Millikin University
Decatur, Ill.

More comment on a materials society

To the Editor:

I have been waiting for a further discussion on SAMPE and the establishment of a new national materials engineering society, as discussed in the Oct '59 issue of your magazine (pp 249 and 250).

I was looking particularly for a discussion by a working materials engineer. I am such an engineer, and the comments that follow are purely personal views.

It seems to me that a very important point has been overlooked by Messrs. LaQue and Clauser. The materials engineer is not one who satisfies a prime social need by designing a product to fit a specification; rather, his is a service function backing up the product designer.

Unless the materials engineer enjoys daily sessions of displaying his erudition to product designers, he must embody his work in standards of some sort. This is the end product of the materials engineer's creative work in selection, evaluation and application of materials. With this point of view in mind, the materials engineer is not a regurgitating library substitute for a product designer: he is a creator and coordinator of engineering knowledge which anyone of sufficient skill can apply.

I have found that the work of the ASTM is not that of a mere publication agency. Standards do not spring full-blown from someone's forehead as Athena was said to have sprung from Jove's forehead.

It takes truly scientifically programmed research to develop the data upon which a standard rests. Close reading of the *ASTM Bulletin* and frequent attendance at committee sessions will soon convince one that the ASTM is truly a materials engineering

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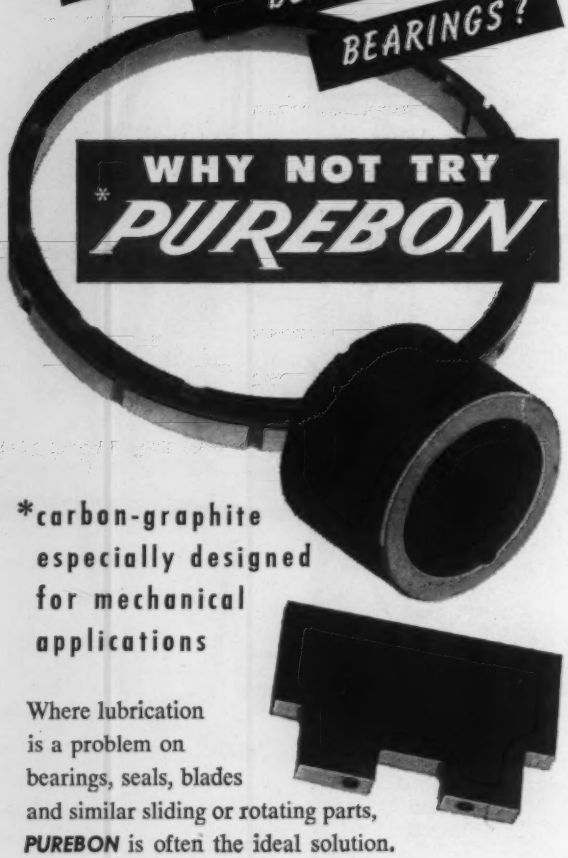

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society and, moreover, takes the practical approach of formulating the results of its work in a useful form, i.e., working standards which are available to all.

I am a member of four learned societies now, and somehow I do not feel a strong urge to spend either time or money to participate in a fifth. I would hate to feel that some of my colleagues are planning to divert information I need in my work into channels which will cost me additional time and money to explore.

Let's use the societies we have now to the fullest extent. Otherwise we might create another technical hierarchy with vested interests in journals that might compete with established engineering journals.

The new national society will also require attendance at meetings, dues to support the staff, new committees, buildings for headquarters, and everything else that goes with a national society.

We have enough scientific overhead now. Let's collect some dividends.

ROBERT S. SHANE
Consulting Engineer
Utica, N. Y.

We agree with most of what Mr. Shane says. We believe that the development of specifications and standards is perhaps the most important single job that the materials engineer has to do, and considering everything, ASTM is doing a good job.

However, as our editorial pointed out, ASTM's present organizational framework, based entirely on committees, is not adequately serving other important needs of the materials engineering function. For example, it has not successfully provided the opportunity for engineers to discuss their practical everyday problems. It is encouraging to note that ASTM is presently studying its organizational setup, to see how it can better serve the materials field. (HRC)

Zeiss electron beam welder

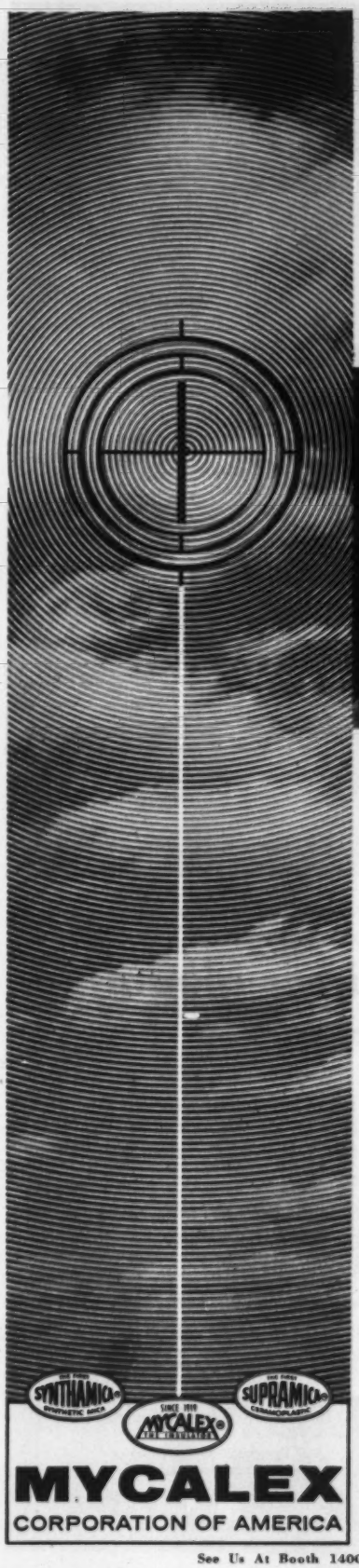
To the Editor:

In your article, "The New Welding Processes," Jan '60, p 105, you referred to the high voltage Zeiss electron beam welder. I would like to build a scale model of this machine and would appreciate it if you could give me any information on the design.

JACK WAKELIN
Southboro, Mass.

We suggest contacting Hamilton Standard, Div. of United Aircraft Corp., Windsor Locks, Conn. This company, under agreement with Zeiss of West Germany, will manufacture the "Hamilton-Zeiss" electron beam welder this year. Sales will be handled by Hamilton-Electrons, Inc., 40 Wall St., New York City.

WIN CASH—Each month $10 will be paid for the best letter written to an author (through us), an editor, or addressed to this column. We reserve the right to withhold awards.



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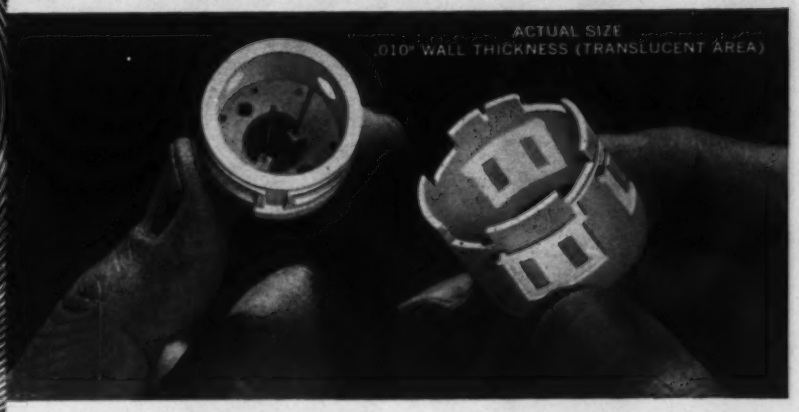

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PRICES & SUPPLY

...AT A GLANCE

A price reduction on low and medium density polyethylene has been announced by Phillips Chemical Co. The new price, 32½¢ per lb in carload lots, is in line with polyethylene price reductions announced earlier by Koppers, Spencer Chemical and Union Carbide Plastics (see M/DE, Feb '60, p 23). Prices of Phillips' high density polyethylenes, ethylene copolymers and tailored resins are unchanged.

Steel plates in widths up to 210 in. will be rolling off a new plate mill early in 1962. Widest steel plates available now measure 160 in. The mill, now under construction at U. S. Steel's Gary, Ind. works, will be capable of rolling single plates weighing as much as 60,000 lb.

Production of man-made natural rubber, cispolyisoprene, will not be pushed at present, say N. J. Broadway and S. Palinchak of Battelle Memorial Inst. They also say that man-made natural rubbers will probably receive a sharp challenge from a relatively new synthetic, cis 1,4-polybutadiene. Up to now, only developmental quantities of this synthetic were available. However, Phillips Chemical Co. recently announced plans to boost output to 20,000 long tons per year.

Zinc consumption in 1959 climbed 7½% over 1958, according to J. L. Kimberley, vice president of American Zinc Inst. In the area of die castings, Kimberley says zinc's position has been strengthened materially in the automotive market because of improved electroplating techniques (see M/DE, Mar '60, p 172).

Price reductions up to 50% on nylon tubular bars were announced recently by Polymer Corp. The reductions, applicable to a specially formulated bearing composition, are said to bring the price of nylon tubular bars to as much as 15% below the price of quality bronze bushings of similar size.

Porous silver sheets are now available in production quantities from Pall Corp.'s Micro Metallic Div., 30 Sea Cliff Ave., Glen Cove, N. Y. Standard sheet sizes are 6 by 9 in., in thicknesses from 1/32 to 1 in. Porosity ranges from 2 to 55 μ.

Another source for man-made industrial diamonds will be Norton Co. Commercial production of the diamonds is not yet planned, according to M. P. Higgins, Norton president. Other producers are General Electric Co. (see M/DE, Dec '57, p 178), and De Beers Consolidated Mines Ltd. (M/DE, Jan '60, p 21).

Inflatable metal tubing, introduced last fall (see M/DE, Sept '59, p 138) will be in full scale production in three to six months, says Wolverine Tube Div. of Calumet & Hecla Inc.

Steel production by the L-D oxygen method is expected to account for 35% (120 million tons) of the world's steel capacity by 1965, according to W. Hitzinger, president of United Austrian Iron and Steel Works. Present U. S. producers of L-D oxygen steel are Kaiser Steel Corp., Jones & Laughlin Steel Corp., McLouth Steel Corp., and Acme Steel Co.

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With Logosols you can look forward, too, to improved shelf life and improved flow characteristics and color stability from batch to batch. We have a cost-value analysis chart you might like to check through that lists more of these problems and their causes. We send it along with our brochure on Logosols (BEE's trade name for vinyl plastisols and organosols). The purpose of the chart is not to point out problems you might know all too well, but rather to briefly show how Logosols can help

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Design Show

Be sure to see pp 57-65 for complete details on registration, technical program and exhibitors at the 5th annual Design Engineering Show and Conference, May 23-26, in New York.

Highlights of this year's Conference are the talks to be given on new welding processes, metal part fabrication by explosives, high strength steels and nonmetallic structural materials. Abstracts of these papers appear on page 59.

World Powder Metallurgists to Meet in U.S. First Time

The first International Conference on Powder Metallurgy to be held in the United States is scheduled for June 13-15 at the Biltmore Hotel in New York City.

The Conference is sponsored by the Metal Powder Industries Federation and the Powder Metallurgy Committee of the Institute of Metals Div. of AIME. It will consist of various symposia and special reports on all aspects of powder metallurgy conducted by scientists and scholars from all over the world.

Program has broad scope

Among the many topics of interest to be covered are:

Powder metallurgy fundamentals and theory: theory of solid state sintering; sintering of organic materials; mechanism of liquid phase sintering; microhardness in powder metallurgy research; and high density sintering of metal powder compacts.

Dispersion strengthening: the role of powder metallurgy in developing dispersion strengthening alloys; a theory of dispersion strengthening; properties of nickel-containing dispersed thorium oxide; and dispersion strengthened steels.

Technology and methods: roll forming; hot extrusion; hydrostatic pressing; slip casting; explosion forming; lubricants; and large parts.

Alloys, materials, applications: refractory metals; molybdenum and tungsten alloys; heat resistant materials; influence of processing and design variables; European trends; pre-alloyed aluminum powder; titanium and zirconium; friction materials; shrinkage; and beryllium.

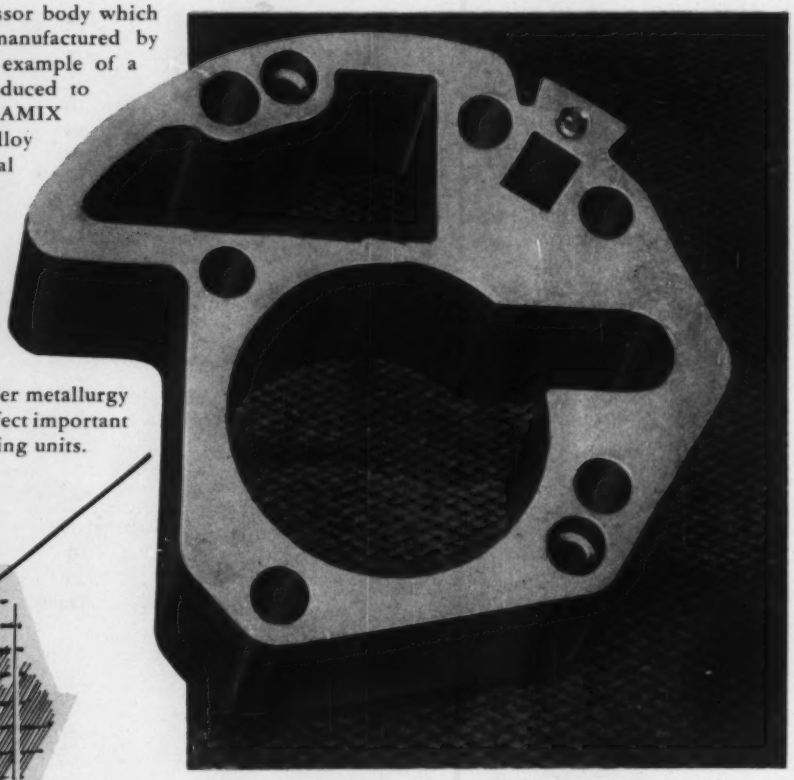
This country's largest extrusion press is now in operation at Aluminum Co. of America's Lafayette, Ind., Works. The 14,000-ton press is capable of extruding "single pieces of aluminum in extreme lengths, with widths up to 39 in., and weighing as much as 2500 lb." The press will be used to produce large nonmilitary components, such as 20-in. seamless pipe, column covers and curtain walls, big tubes for masts and booms in merchant vessels, hydrofoils, deckhouses, highway signs and many other structural shapes now being built up from small pieces.

ASTM Committees Report on Materials

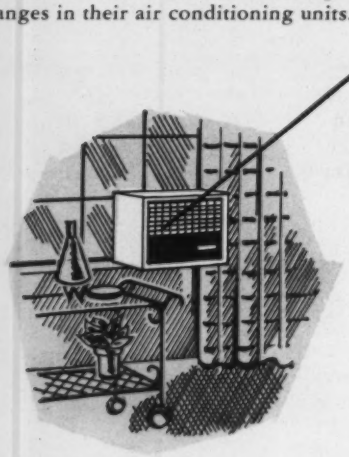
This year's annual ASTM Committee Week, held recently in Chicago, nearly broke a record: over

GRAMIX® COMPRESSOR BODY IS VITAL PART IN GENERAL ELECTRIC AIR CONDITIONER... this GRAMIX part is a new concept in powder metallurgy techniques . . . engineered to meet requirements of GENERAL ELECTRIC's new compressor design

This large, complex shaped compressor body which is employed in air conditioners manufactured by General Electric is an outstanding example of a GRAMIX part engineered and produced to exacting specifications. As in all GRAMIX products of powder metallurgy, the alloy was created to meet exacting physical properties required in this particular application. Correct briquetting, controlled sintering procedures, precise finishing operations and rigid quality control throughout the manufacturing process assures General Electric uniform, dependable GRAMIX parts. The production of this body as a product of powder metallurgy has also enabled General Electric to effect important design changes in their air conditioning units.



This part is shown full size. Actual weight: 2¼ lbs.



PM MEMBER

Write today for these helpful engineering manuals. Engineering Bulletin No. 18 covers design and metallurgical requirements and alloy selection of GRAMIX bearings. No. 19 contains facts about GRAMIX Machine Parts and No. 21 contains general information on GRAMIX products from Powder Metallurgy. Get your copies now.

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1400 engineers and scientists from 35 technical committees held 351 meetings on practically all phases of engineering materials specifications and standards.

Aluminum surfaces

One of the highlights of the Committee Week was a panel discussion on appearance of aluminum surfaces. After some interesting talks and discussion of measurement techniques and standards, the panel concluded that all that had been done successfully thus far was to define the enormity and complexity of the problem.

Other reports of interest

▸ Committee A-5 on Corrosion of Iron and Steel has completed work on a new specification covering zinc-coated (galvanized) iron and steel sheets, a new atmospheric exposure test for galvanized and aluminum-coated steel corrugated roofing sheets, and new test methods for porosity and uniformity of aluminum coatings.

▸ Committee A-6 on Magnetism has reached agreement on density-composition relationships for measurement of the magnetic properties of iron-aluminum alloys.

▸ Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys has added low carbon grades of stainless steel castings to specification A296. The grades added are CF-3, CF-3M, CG-8M, HD, HL and HN.

▸ Also: 1) ASTM specifications for wrought aluminum and aluminum alloys will now identify these alloys by the Aluminum Assn. designations; 2) transparencies of the 22 grain sizes now included in Plate I of ASTM method E-112 for estimating average grain size of metals will be offered for sale; and 3) a conversion table for hardness and tensile strength of steel has been prepared jointly by ASTM, the Society of Automotive Engineers, the American Society for Metals and the Armed Services.

Meeting on Columbium Metallurgy

A special two-day meeting on columbium metallurgy has been planned for June 9-10 at Lake George, N. Y.

The program, sponsored by the Hudson-Mohawk section of the American Institute of Mining, Metallurgical and Petroleum Engineers, will be divided into four parts: 1) mechanical properties—tensile, creep rupture, impact and fatigue strengths as influenced by alloying, environment and treatment; 2) fabrication—discussions of conversion, shaping and joining of columbium and its alloys; 3) corrosion—oxidation-chemical reactions with liquid and gaseous environments and effects of coatings; and 4) physical metallurgy—phase equilibria, kinetics, textures, radiation damage and related problems.

SAMPE Discusses Superalloys

Fabrication limitations previously associated with René 41 (a relatively new nickel-base superalloy) are now less serious, according to Louis Weisenberg, Flight Propulsion Div., General Electric Co.

Mr. Weisenberg, speaking at the recent SAMPE Symposium on Processing Materials for Re-Entry Structures, pointed out that heat treatments can be suited to the particular design application. Separate treatments, for example, have been devised to provide maximum tensile properties, optimum rupture properties, and best conditions for forming and welding.

Other papers presented at the Symposium covered the different materials problems encountered with manned, unmanned and winged re-entry vehicles. The fabrication, welding and use of refractory alloys were covered in a number of papers. Graphite, ceramic and ceramic-metal materials systems were also discussed.

Most papers stressed the critical nature of fabricating, joining, fastening and coating problems in the present high temperature era.

Steering committee votes to nationalize

During the business meetings, a steering committee formed of delegates from all SAMPE groups voted that the organization will henceforth be a national, unified society. The first national meeting will be held in the fall of 1960 at which time it is expected that the present nine chapters will be joined by groups from San Diego, San Francisco and Seattle.

(continued on p 204)

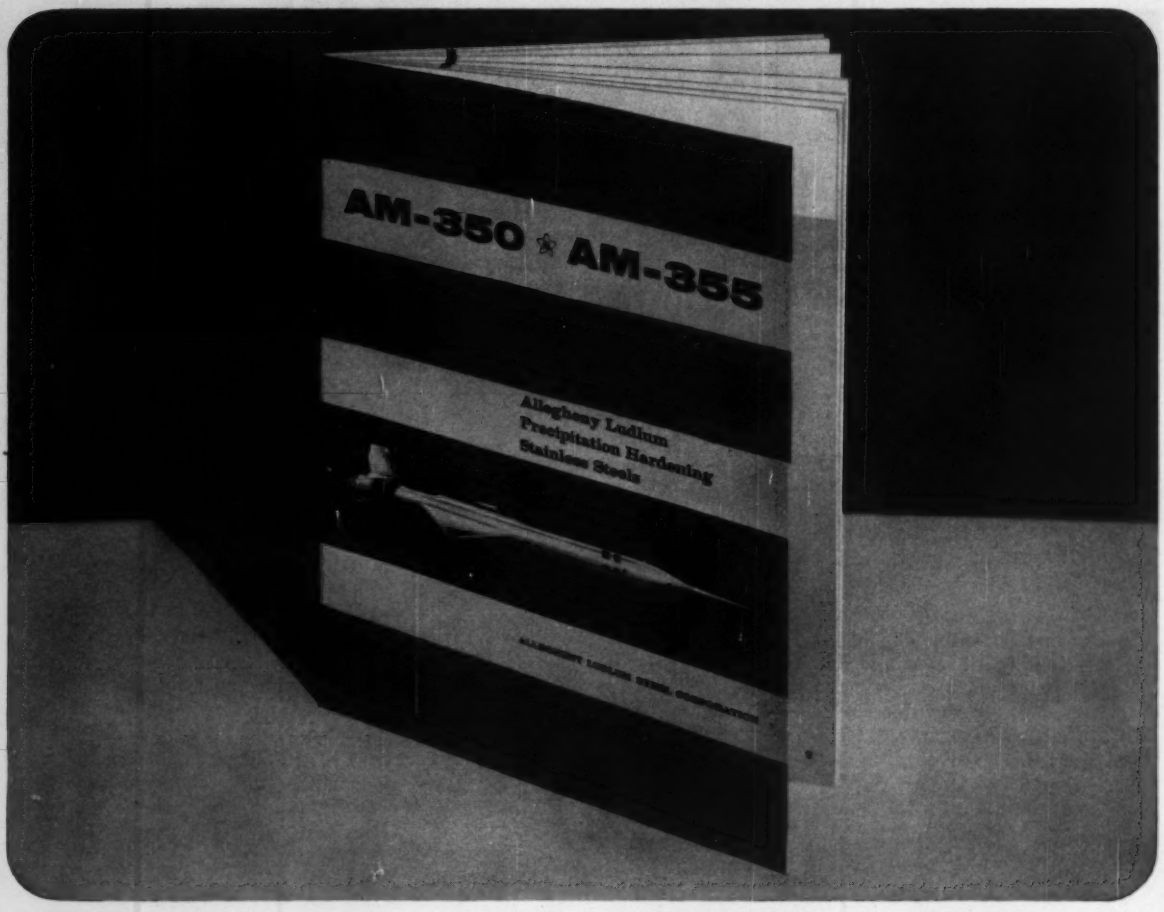
News of Societies

American Society for Metals has established the following three new awards: The William Hunt Eisenman Engineering Award, to be given annually for "outstanding contributions in the practical application of the science of metallurgy to the production of metals or their engineering use"; The William Hunt Eisenman Teaching Award for "outstanding teachers of metallurgy or related sciences"; and The Marcus A. Grossmann Young Authors Award, to be granted to "authors under age 35 of the most outstanding paper in *ASM Transactions*."

Brass & Bronze Ingot Inst. has established an annual award competition for the best new or projected uses of bronze or brass castings. Entry deadline for the contest is June 15.

Coming Meetings on next page; more News on p 204

Experience—*the added alloy in* **Allegheny Stainless**



New booklet on A-L's precipitation-hardening stainless steels, AM-350 and AM-355

A tool for anyone interested in high strength-to-weight metals

In this technical booklet, you get the facts on Allegheny Ludlum's precipitation hardening stainless steels, AM-350 and AM-355, metals developed for space age requirements.

AM-350 and AM-355 combine these unusual qualities. They are easy to fabricate. Have high strength-to-weight ratios at room and elevated temperatures combined with excellent resistance to corrosion.

The physical and mechanical properties of the two metals are described in 33 charts and tables. Included are heat-treatment and fabrication data, eight photomicrographs and a section on corrosion resistance with representative values in selected environments.

It's jam-packed with data. For your free copy, see your A-L representative or write *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa. Address Dept. MI-5.*

355

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EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT

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Coming Meetings

SOCIETY FOR NONDESTRUCTIVE TESTING, semi-annual meeting. Dallas. May 9-12.

2ND SOUTHWESTERN METAL EXPOSITION AND CONGRESS, American Society for Metals. Dallas. May 9-13.

1960 CASTINGS CONGRESS AND EXPOSITION, American Foundrymen's Society. Philadelphia. May 9-13.

PRODUCTION ENGINEERING CONFERENCE, American Society of Mechanical Engineers. Milwaukee, Wis. May 17-19.

SOCIETY FOR EXPERIMENTAL STRESS ANALYSIS, 1960 national spring meeting. Indianapolis. May 18-20.

ELECTRONIC INDUSTRIES ASSN., annual meeting. Chicago. May 18-20.

DESIGN ENGINEERING CONFERENCE, Machine Design Div., ASME. New York City. May 23-26.

DESIGN ENGINEERING SHOW, New York City. May 23-26.

AMERICAN SOCIETY FOR QUALITY CONTROL, annual meeting and exhibit. San Francisco. May 24-26.

REFRACTORY MATERIALS AND ALLOYS SYMPOSIUM, AIME. Detroit. May 25-26.

NEW ENGLAND REGIONAL CONFERENCE ON NEW DEVELOPMENTS IN METALWORKING, Metallurgical Society, AIME. Boston. May 26-27.

AVIATION CONFERENCE and summer annual meeting, American Society of Mechanical Engineers. Dallas. June 5-9.

SOCIETY OF AUTOMOTIVE ENGINEERS, INC., summer meeting. Chicago. June 5-10.

AMERICAN NUCLEAR SOCIETY, 6th annual meeting. Chicago. June 12-16.

INTERNATIONAL POWDER METALLURGY CONFERENCE, Metal Powder Industries Federation and Institute of Metals Div., Metallurgical Society of AIME. New York City. June 13-15.

ALLOY CASTING INSTITUTE, annual meeting. Hot Springs, Va. June 19-21.

APPLIED MECHANICS CONFERENCE, American Society of Mechanical Engineers. Penn State University. University Park, Pa. June 20-22.

AMERICAN SOCIETY FOR TESTING MATERIALS, 63rd annual meeting and exhibit. Atlantic City. June 26-July 1.

First cost doesn't measure true value

Take a high alloy casting designed for severe service. Two suppliers quote from the same drawing – same configuration, same composition: One supplier – with no proven background in high alloy work – quotes an apparently lower price than the other.

Should you grab the low-price supplier without investigating? Producing a heat or corrosion resistant casting that stands up is not just a matter of "making a pattern and pouring metal". It is a matter of:
(1) proper alloy control;
(2) foundry techniques adapted to the job;
(3) personnel who know best current practices and who understand casting design.

The moral: Be sure you are dealing with an experienced high alloy foundry.

ACI **ALLOY CASTING INSTITUTE**
1001 Franklin Ave./Garden City, New York
... For technical information on corrosion resistant and heat resistant castings

May we send you the new ACI Technical Publications List and the 1960 List of Alloy Designations? Both free for the asking.

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THESE 13 SPECIAL ALLOYS FROM *can help you solve design problems . . .*

As the result of the knowledge gained over the years by working closely with hundreds of customers in helping solve innumerable design and production problems, the Mueller Brass Co. has developed a series of special alloys for use in tough or unusual applications.

This group of special alloys, each having distinct characteristics and advantages, are available in rod form in many sizes and shapes as well as forgings.

CHARACTERISTICS AND APPLICATIONS	ALLOY NO.	NAME	TEMPER
TUF-STUF® ALUMINUM BRONZES AND NICKEL ALUMINUM BRONZES have great strength characteristics. All are more resistant to corrosion cracking under load than copper-zinc alloys and, in addition, some are heat-treatable. They can withstand heavy pounding and have proved excellent for such parts as gibs, cams, valve seat inserts, shifting forks and propeller hub cones.	224E-30	"Tuf-Stuf" Aluminum Bronze	BRINELL 1000 KG load 165
	224E-75	"Tuf-Stuf" Aluminum Bronze	BRINELL 1000 KG load 175
	224C	"Tuf-Stuf" Aluminum Bronze	BRINELL 1000 KG load 185
	224H	"Tuf-Stuf" Aluminum Bronze	BRINELL 1000 KG load 200
	224K	"Tuf-Stuf" Nickel Aluminum Bronze	BRINELL 3000 KG load 250
ALUMINUM SILICON BRONZE is free turning; has high strength, is corrosion resistant and non-magnetic and resistant to corrosion cracking under load.	802	Aluminum Silicon Bronze	ROCKWELL-B 75
600 SERIES® FORGEABLE BEARING ALLOYS range from high strength to low loaded ductile. All are corrosion resistant, free cutting, can be used with hard or soft mating members and can be soldered. They are employed in a great variety of applications ranging from pump gears and valve stems to pinion shafts and transmission rings.	600	Forgeable Bearing Alloy	ROCKWELL-B 88
	601	Forgeable Bearing Alloy	ROCKWELL-B 87
	602	Leaded Forgeable Bearing Alloy	ROCKWELL-B 87
	604	High Leaded Forgeable Bearing Alloy	ROCKWELL-B 86
	605	Low Leaded Forgeable Bearing Alloy	ROCKWELL-B 80
MANGANESE BRONZE ALLOYS are exceptionally strong, tough, resistant to shock and corrosion. Good for screw machine products and forgings for aircraft parts.	241A	Manganese Bronze A	ROCKWELL-B 85
	721	Manganese Bronze High Tensile Grade B	BRINELL 1000 KG load 200
TELLURIUM COPPER has very high electrical and thermal conductivity combined with good corrosion resistance and machinability. Excellent for electronic components.	799	Tellurium Copper	ROCKWELL-B 45

NOTE: The values shown are average values normally obtained in production. Variations must be expected in practice. The values should be used as a general guide rather than the basis for specifications.

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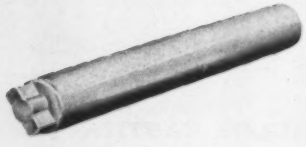

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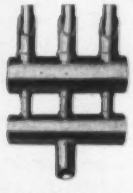

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Regardless of your responsibility... design, specification, production or purchasing... Mueller Brass Co. special alloys can help you lower costs and improve your products. Call the "Man From Mueller Brass Co." today and put these remarkable alloys to work on your toughest jobs.

Yield Strength at 0.5% Extension Lbs./Sq. In.	Tensile Strength Lbs./Sq. In.	Relative Machinability Free Cutting Brass=100%
50,000	82,000	30
65,000	100,000	30
62,000	95,000	35
70,000	90,000	30
65,000	105,000	20
35,000	85,000	60
60,000	90,000	25
55,000	78,000	35
65,000	85,000	65
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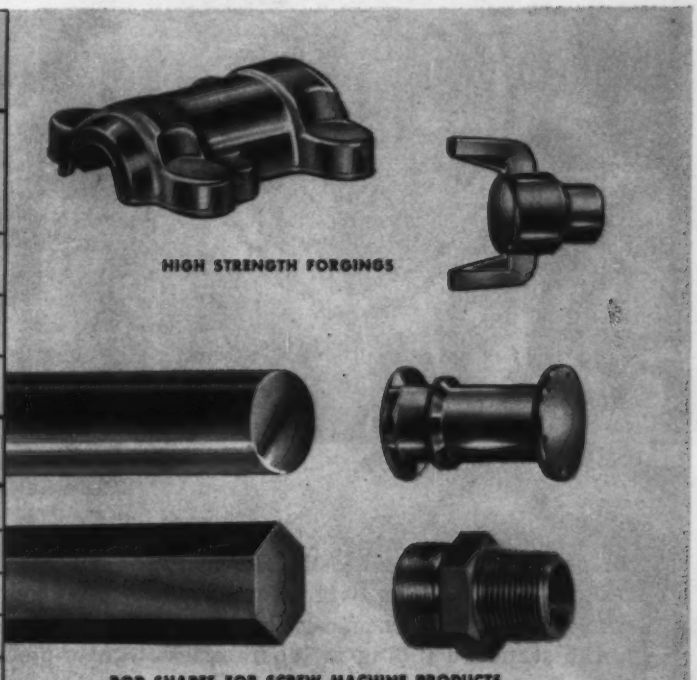
45,000	70,000	55
55,000	78,000	25
68,000	115,000	35
40,000	43,000	90



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ROD SHAPES FOR SCREW MACHINE PRODUCTS

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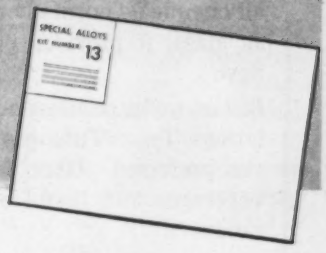
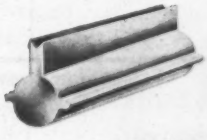


ALL THESE QUALITY PRODUCTS

SAND CASTINGS



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TYGON® *plastic* TUBING

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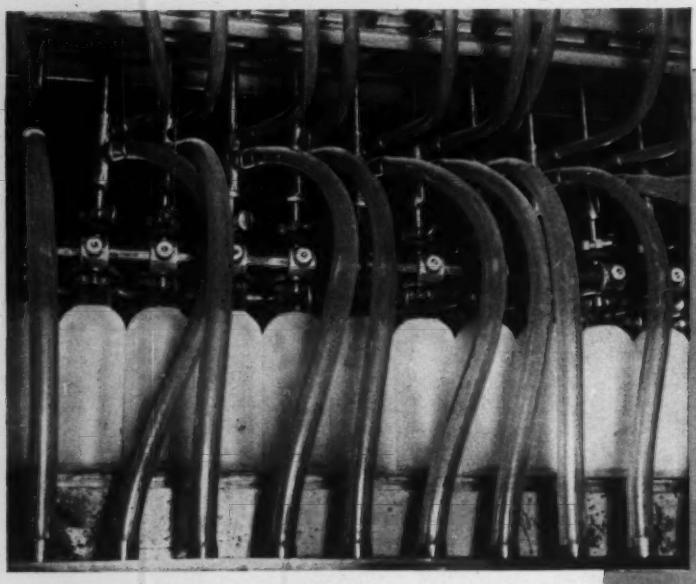

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- HANDLE CORROSIVE LIQUIDS OR GASES
- TRANSMIT FOODS, DRUGS, BEVERAGES OR OTHER HIGH PURITY AND/OR SENSITIVE SOLUTIONS
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Tough, flexible Tygon plastic Tubing is resistant to an extremely broad range of corrosive gases and chemicals. In fact, it is the standard tubing in laboratories throughout the world, handling virtually all chemicals normally encountered. Clear as glass, it provides perfect visibility of flow.

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Flexible as a piece of string, available in continuous lengths, Tygon Tubing requires few joints or couplings, is quickly installed in minimum space. Its highly-polished bore provides outstanding flow characteristics, prevents interior build-up, permits simple flush-cleaning. Non-aging and physically tough, Tygon retains its unique combination of advantages throughout a long, trouble-free service life.

One of seven standard Tygon formulations will almost certainly meet your requirements. Special formulations have been developed for unusual needs. Over 65 standard sizes up to 4″ I.D. are available.

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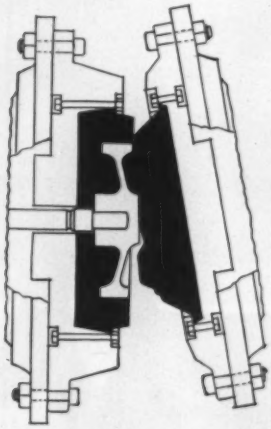
Unique Mill Forges and Rolls circular products in one operation

In less than one minute, this Bethlehem mill—the only one of its kind in the country—turns out a top-quality impression-die steel forging at a cost that's hard to match.

This is Bethlehem's famed circular-products mill—the Slick Mill. Named for its designer, Edwin E. Slick, this unique machine produces impression-die circular forgings ranging from 10 in. to 46 in. OD; as-rolled weights ranging from 100 to 2,000 lb. It handles almost any grade of steel—carbon, alloy or stainless, as well as certain heat-resistant grades.

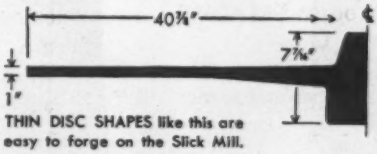


How It Works

Designed to operate in a horizontal plane, Bethlehem's Slick Mill is constructed with two *revolvable* spindles on which face plates are mounted. These face plates support the impression dies that form the steel billet into shape by a combination press and rolling action.

After the steel billet is heated and descaled, it is centered between the dies of the Slick Mill. Then a 1500-ton hydraulic ram actuates the spindle on the straight side of the mill, upset forging the billet. When this cycle is completed, a 2,000-hp motor actuates the spindle on the angle side of the mill and the rolling cycle begins. By continuing the upsetting action and rotation of the dies and work, the material flows into the recesses of the dies, resulting in the desired shape. *The entire rolling cycle takes about one minute.*

After rolling, excess material in the form of flash is sheared off; the hub, when necessary, is punched; and the forging is inspected.



THIN DISC SHAPES like this are easy to forge on the Slick Mill.

Cost-Saving Features

Quick operation: Only one minute is needed to convert a heated slug into a contoured forging, whether the product weighs 100 or 2,000 lb.

Quick die changes: Only 15 minutes are needed to change and set up dies. Even production runs as small as 25 or 50 pieces are economical.

Low die charges: Since contact time between die and work is very brief, and because there is no impacting, low-cost die blocks can be used. In many cases, die charges are ⅓ to ½ less than conventional impression dies.

Less steel needed: Utilizing the principle of forging design, the Slick Mill can produce lighter-weight sections without sacrificing strength.

Good physical characteristics: The process insures excellent grain flow, machinability and soundness.

Bethlehem's Slick Mill is readily adapted to jobbing or production quantities of forged circular products such as: gear blanks, fly wheels; crane track wheels; sheave wheels; brake drums; clutch discs; couplings; tire moulds; and turbine or compressor wheels. Products may be specified as-rolled or rough machined to specifications.

Your inquiry—whatever the quantity involved—will receive prompt attention. Call or write the Bethlehem sales office nearest you today.

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EVEN ON THIS EXTRA-TOUGH JOB...

N-A-XTRA

HIGH-STRENGTH STEEL TRIPLES TRUCK LIFE!

Hour after hour, around the clock, the Edward C. Levy Slag Company, Detroit, keeps forty 45-ton trucks working under severe conditions. Nearly 30 tons of hot slag are loaded, lifted and dumped on every trip. Each time, the truck body must stand the sudden shock of drop loading, the stress of lifting that load and the grinding abrasive action as it empties.

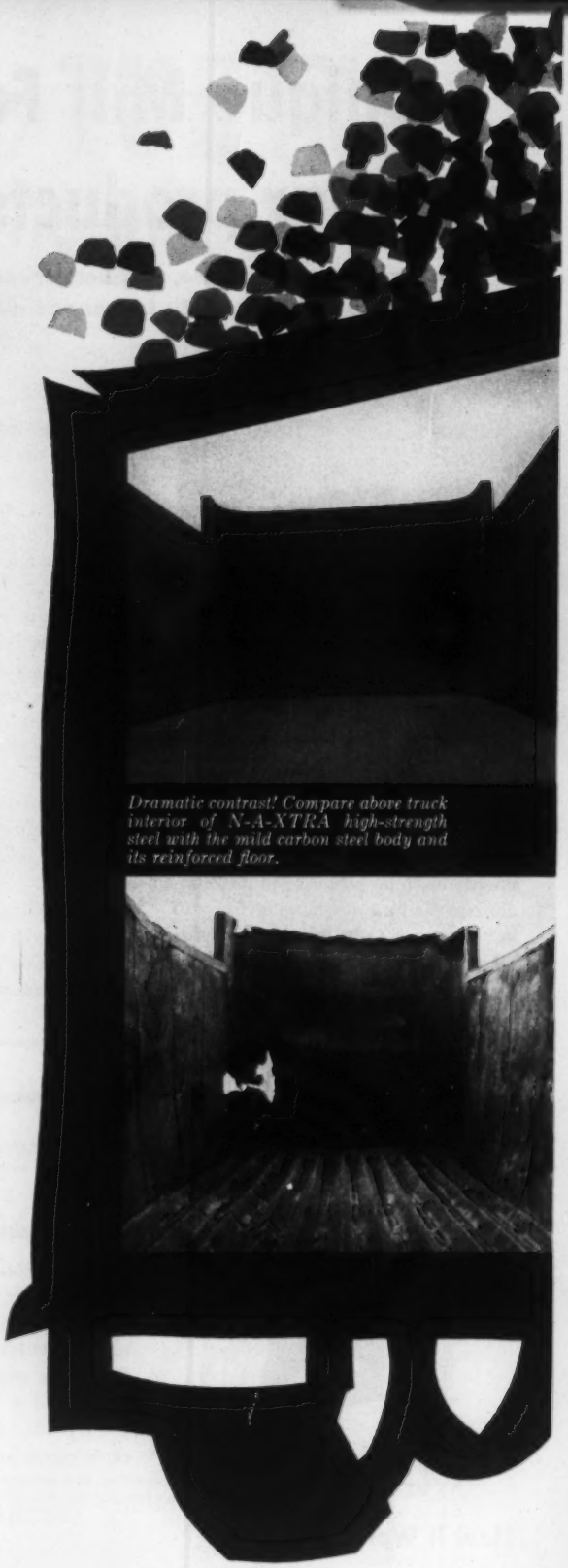
How long can a truck body take such a beating?

Until the company (which designs its own trucks) discovered N-A-XTRA high-strength steel, they used ordinary carbon steel, good for about 18 months' service. Though the truck bodies were as strong as they could be and still carry an adequate payload, maintenance was almost continuous—with breaks, dents, dings and sags occurring almost from the start.

Then they fabricated eight bodies out of N-A-XTRA, which has a minimum yield strength nearly three times greater than mild carbon steel. These trucks carry the same payload and after 18 months' service still look almost new. Owners estimate a life of five years, more than triple the others—with far less maintenance. The extra strength of N-A-XTRA also permits a strong floor that needs no expensive reinforcement to support the load against hydraulic lift action.

Eventually, all forty Edward C. Levy trucks will be made of N-A-XTRA high-strength steel. In fact, all patches and section replacements are now made with N-A-XTRA.

Tons of hot, abrasive slag may not be your problem—but the same steel that mastered these conditions is the one to remember when only the strongest steels will do. Rugged conditions, heavy loads and weight-saving construction are challenges that N-A-XTRA is designed to meet and beat. With excellent weldability, formability and toughness, these quenched and tempered N-A-XTRA steels are available in four levels of minimum yield strength, from 80,000 to 110,000 psi. They can also be supplied to higher levels of mechanical properties.



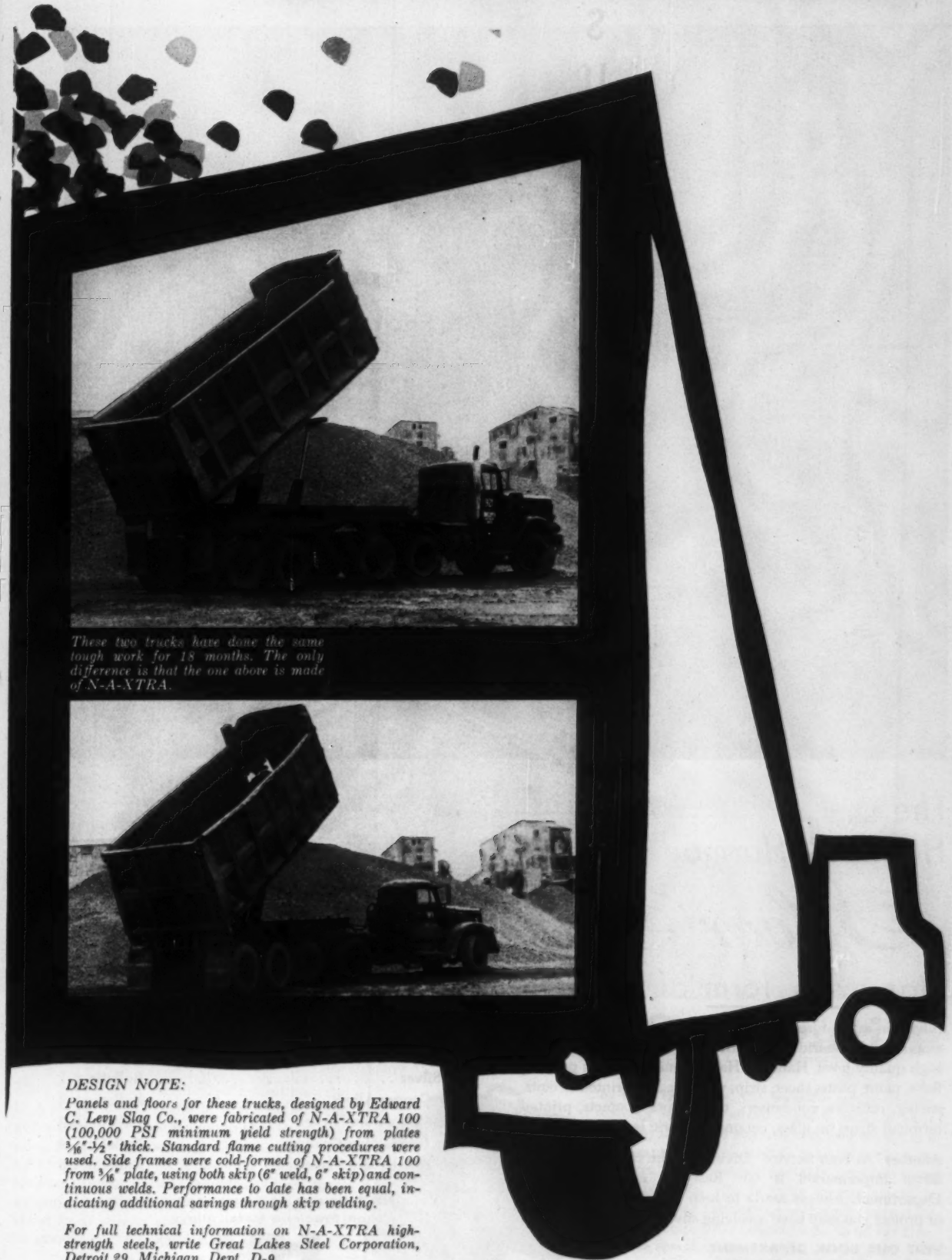
Dramatic contrast! Compare above truck interior of N-A-XTRA high-strength steel with the mild carbon steel body and its reinforced floor.

N-A-XTRA

A PRODUCT OF

GREAT LAKES STEEL

Detroit 29, Michigan



These two trucks have done the same tough work for 18 months. The only difference is that the one above is made of N-A-XTRA.

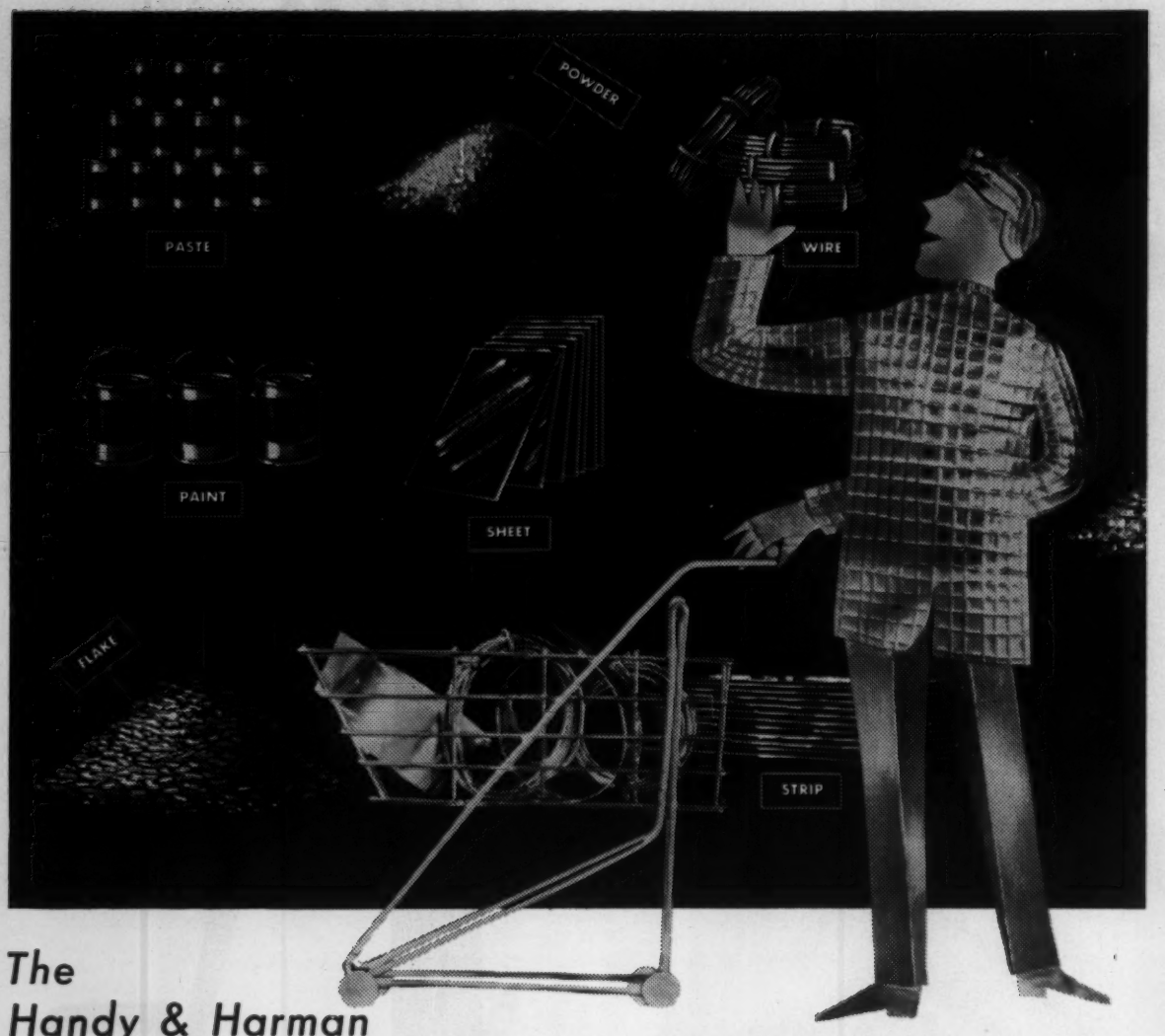
DESIGN NOTE:

Panels and floors for these trucks, designed by Edward C. Levy Slag Co., were fabricated of N-A-XTRA 100 (100,000 PSI minimum yield strength) from plates 3/16"-1/2" thick. Standard flame cutting procedures were used. Side frames were cold-formed of N-A-XTRA 100 from 3/16" plate, using both skip (6" weld, 6" skip) and continuous welds. Performance to date has been equal, indicating additional savings through skip welding.

For full technical information on N-A-XTRA high-strength steels, write Great Lakes Steel Corporation, Detroit 29, Michigan, Dept. D-9.

***Great Lakes Steel is a Division of* NATIONAL STEEL CORPORATION**

For more information, turn to Reader Service card, circle No. 441



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We have five Technical Bulletins giving engineering data on the properties and forms of Handy & Harman Silver Alloys. We would like you to have any or all of those that particularly interest you. Your request, by number, will receive prompt attention.

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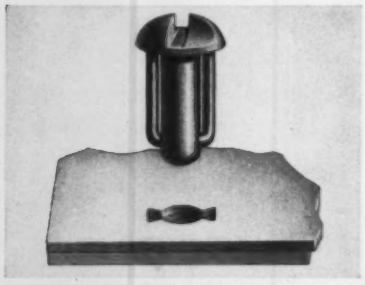

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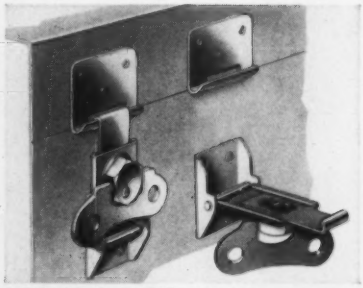
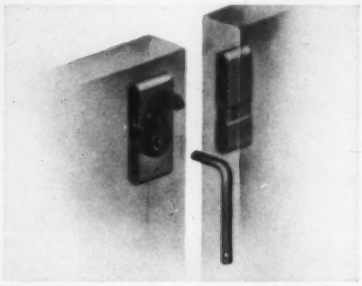


LINK-LOCK–Ideal latching device where heavy locking pressure is necessary. Available in heavy, medium, light duty, for use in military and commercial containers and demountable construction.



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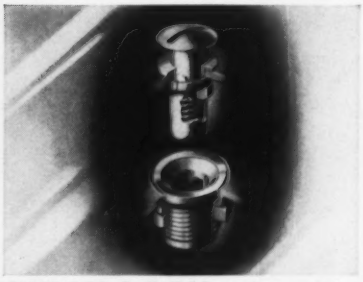

QUICK-LOCK–For assembling removable panels and access doors. Locked by a 90° turn. Various sizes and types, for weather-tight electrical units, cowlings, access panels.

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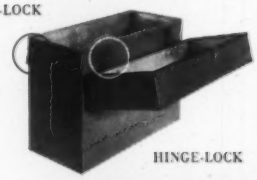

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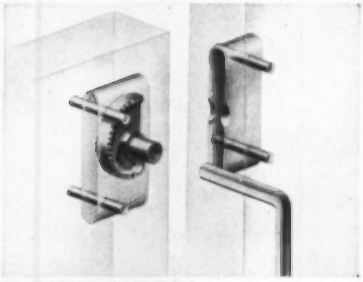

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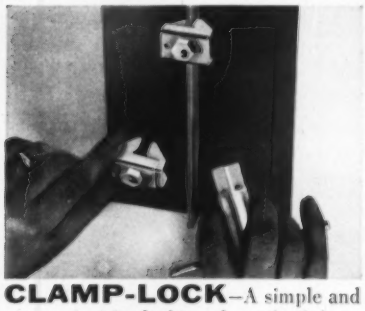

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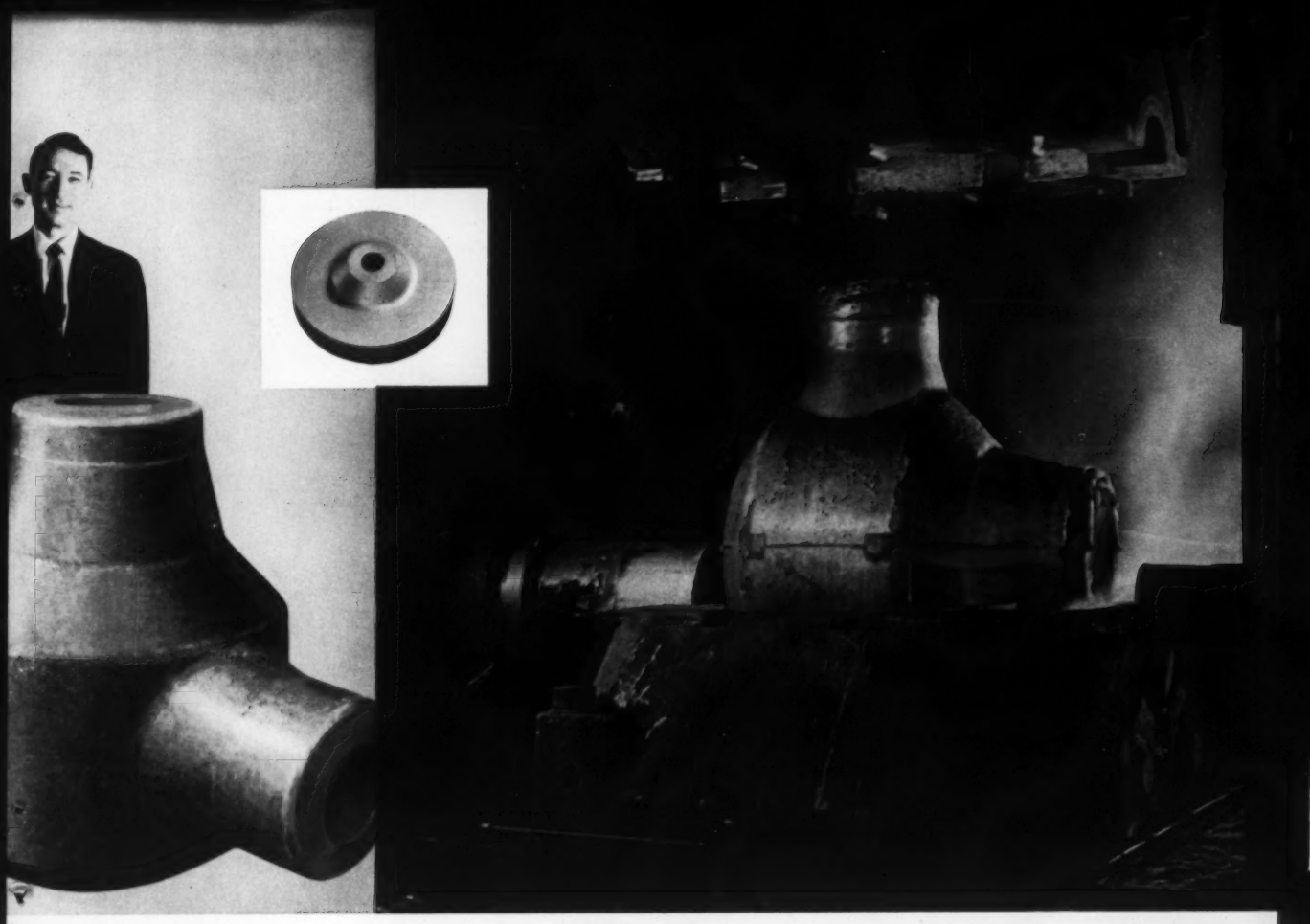

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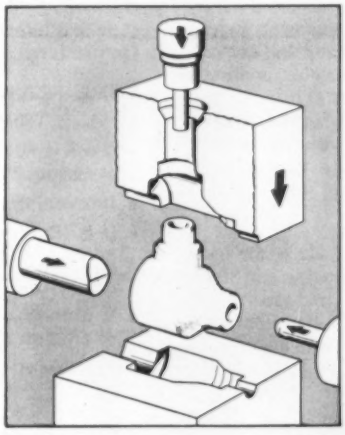

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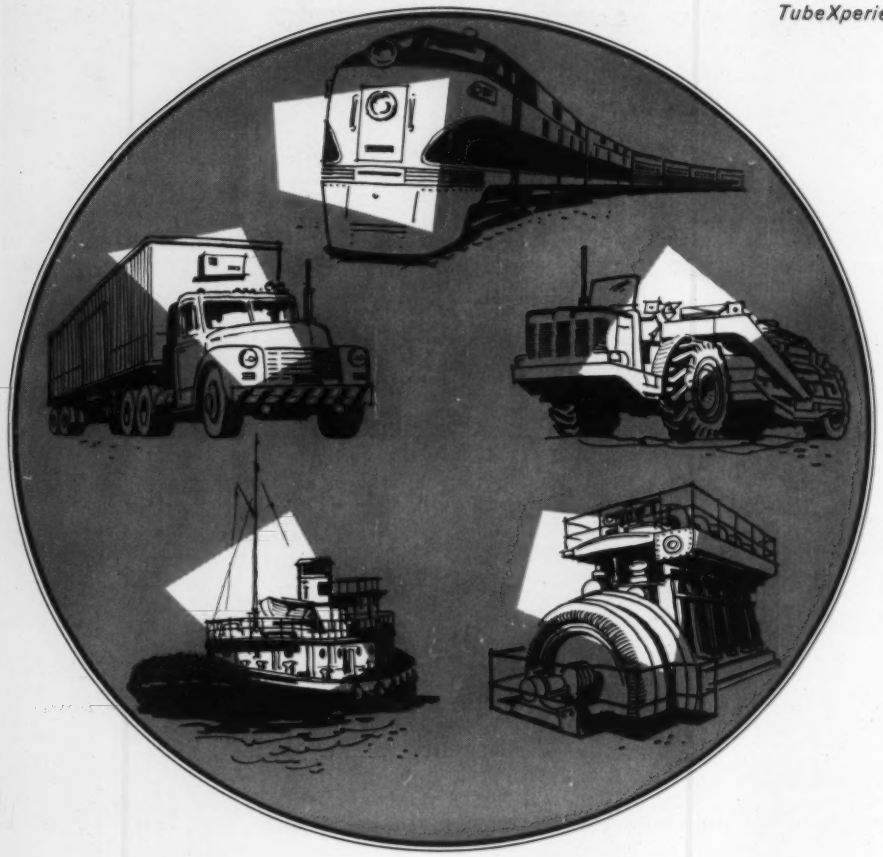

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Fuel injection systems are the heart of thousands of diesel-powered trucks, locomotives, roadbuilding equipment, electric generators, and marine power plants. The tubing that conveys the fuel from injection pump to nozzle assembly is an important component. It must resist the stresses of pressure and vibration, yet be ductile enough to be cold swaged and upset and be cold formed into loops and bends without excessive springback. It must have a clean ID, tremendous burst strength, and high fatigue resistance. Superior diesel fuel injection tubing is just such a premium product.

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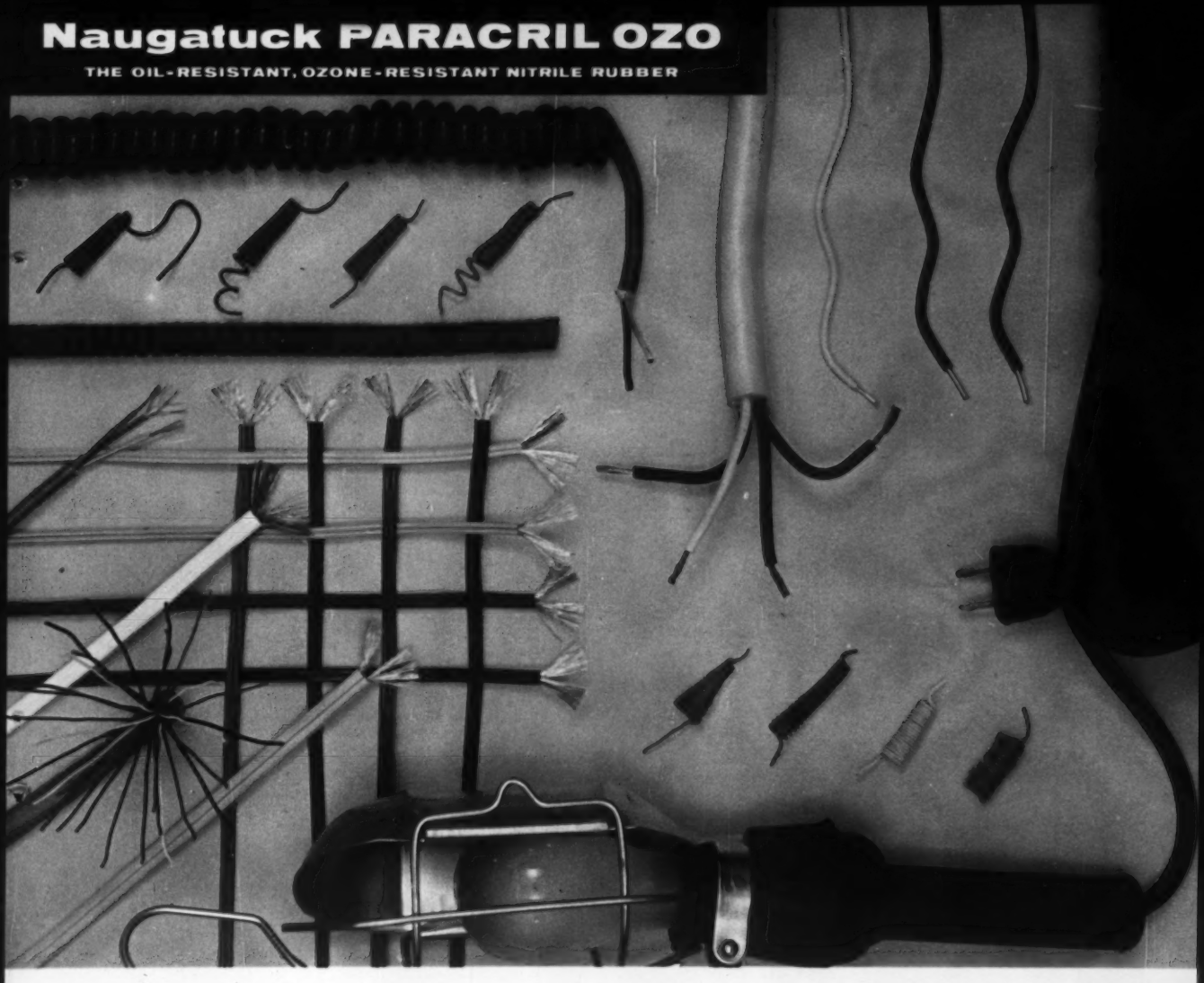

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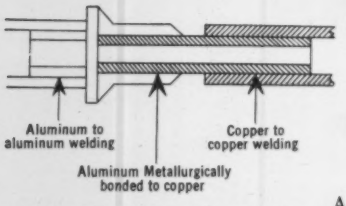

ALCUPLATE® (aluminum clad copper) fabricated into tubing connector solves mechanical joining problem. Aluminum and copper are metallurgically bonded and permit aluminum to aluminum and copper to copper welding for a corrosion-free seal.

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METALS		
Aluminum casting alloys have low shrinkage	15	605
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Cold work die steel	224	623
Coated aluminum foil	238	637
PLASTICS AND RUBBER		
Fluorocarbon plastic is easy to mold	9	600
What's new in premix molding?	12	601
Irradiated polyethylene film	218	621
RTV silicone compounds	224	624
Decorative laminate	235	632
Multicolored plastics parts	252	646
OTHER NONMETALLICS		
Glasses pass infrared, conduct electricity	209	613, 614
Steel-bonded carbide	212	618
Low cost parchment	230	631
Ferroelectric ceramic withstands 600 F	236	633
Refractory material useful to 3000 F	246	643
FINISHES, COATINGS		
Parts aluminized by cold spraying, heating	210	616
Polish for aluminum	256	668
Liquid neoprene rubber paint	256	667
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16	41	66	91	116	141	166	191	216	241	266	291	316	341	366	391	416	441	466	491	516	541	566	591	616	641	666	691
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16	41	66	91	116	141	166	191	216	241	266	291	316	341	366	391	416	441	466	491	516	541	566	591	616	641	666	691
17	42	67	92	117	142	167	192	217	242	267	292	317	342	367	392	417	442	467	492	517	542	567	592	617	642	667	692
18	43	68	93	118	143	168	193	218	243	268	293	318	343	368	393	418	443	468	493	518	543	568	593	618	643	668	693
19	44	69	94	119	144	169	194	219	244	269	294	319	344	369	394	419	444	469	494	519	544	569	594	619	644	669	694
20	45	70	95	120	145	170	195	220	245	270	295	320	345	370	395	420	445	470	495	520	545	570	595	620	645	670	695
21	46	71	96	121	146	171	196	221	246	271	296	321	346	371	396	421	446	471	496	521	546	571	596	621	646	671	696
22	47	72	97	122	147	172	197	222	247	272	297	322	347	372	397	422	447	472	497	522	547	572	597	622	647	672	697
23	48	73	98	123	148	173	198	223	248	273	298	323	348	373	398	423	448	473	498	523	548	573	598	623	648	673	698
24	49	74	99	124	149	174	199	224	249	274	299	324	349	374	399	424	449	474	499	524	549	574	599	624	649	674	699
25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700

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Flocked Paper. Cellusuede Products, Inc., illus. Sample kit containing actual swatches of colored flocked paper. Suggestions for cutting, folding and printing the flocked paper. (137)

Glass Drain Line System. Corning Glass Works, 12 pp, illus., No. PE-30. Properties, specifications, available fittings and design information on the use of glass piping and fittings for disposal of corrosive wastes. (138)

TFE-Impregnated Felt. E. I. du Pont de Nemours & Co., Inc., Fabrics Div., 4 pp. Heat and chemical resistance, mechanical properties and potential uses of TFE fluorocarbon felts impregnated with TFE resin. (139)

Fused Silica, Quartz. Amersil Quartz Co., Div. of Engelhard Industries, 10 pp, illus. Mechanical and electrical properties, uses, heat resistance, handling information and optical properties for fused quartz and silica. (140)

Felt Products. Felters Co., 22 pp, illus. Design information, properties, specifications and uses of felt and felt products. (141)

Wood Products. Gamble Brothers, Inc., 28 pp, illus. Shows wood products manufactured by the company, including industrial wood parts, chair parts and athletic apparatus. (142)

Molded Pump Cups. Garlock Packing Co., 6 pp, illus., No. AD-145. Describes molded leather and rubber pump cups for pump pistons, and hydraulic and pneumatic equipment. (143)

Ceramic Parts. Centralab, Div. of Globe-Union Inc., 16 pp, illus. Design information, mechanical and electrical properties, heat resistance, uses and chemical resistance of ceramic parts. (144)

Specialty Glass Products. Kopp Glass, Inc., 20 pp, illus., No. 553-A. Information on such specialty glass products as lenses, filters, warning beacons, aircraft panel lights, sight glasses and instrument cases. (145)

Glass Products. Lancaster Glass Corp., 28 pp, illus. Case histories on the use of glass in television tubes, auto dome lights, desk sets, refrigerator lights and vending machines. (146)

Carbide Tools. Metal Carbides Corp., 68 pp, illus., No. 59-G. Information on metal carbide tools, dies, blades, wear parts and rolls. (147)

Fiberglass Pipe Insulation. Owens-Corning Fiberglas Corp., 8 pp, illus. Physical properties, design data, thermal efficiency and installation data for fiberglass pipe insulation. (148)

Glass Fiber Insulation. Pittsburgh Plate Glass Co., Fiber Glass Div., 4 pp, illus. Advantages of using glass fibers for sound and heat insulation applications. (149)

Carbon Graphite. Pure Carbon Co., Inc., 12 pp, illus., No. 55. Catalog on carbon graphite for mechanical applications. (150)

Synthetic Fiber Felts. Troy Blanket Mills, Industrial Div., 8 pp, illus. Strength, dimensional stability, wear, moisture and chemical resistance, and uses of a nonwoven synthetic fiber felt. (151)

Finishes • Cleaning & Finishing

Corrosion Inhibitor. Allied Chemical Corp., Solvay Process Div., 17 pp, illus. Use of sodium nitrite in corrosion prevention. (152)

Chromate Conversion Coatings. Allied Research Products, Inc., 28 pp, illus. Discusses chromate conversion coatings for zinc, cadmium, copper, brass, bronze, aluminum, magnesium and silver. (153)

Silver Electroplates. Englehard Industries, Inc., American Platinum & Silver Div., 4 pp. Tells how to silver plate ferrous and nonferrous metals. (154)

Metallized Ceramic Coating. Frenchtown Porcelain Co., 4 pp, illus. Data on Molcote, metal-to-ceramic coating, that may be hard soldered up to 2200 F. (155)

Nickel Alloy Coatings. Kanigen Div., General American Transportation Corp., 12 pp, illus., No. 258. Frictional properties, abrasion, corrosion and salt spray resistance, uses, ductility and thermal conductivity of Kanigen chemically deposited nickel alloy coatings. (156)

Multicolor Enamel. Maas & Waldstein Co., 2 pp, No. 520. Data sheet for industrial multicolor enamels. (157)

Hard Surfacing Electrodes. Metal & Thermit Corp. File cards give data on 88 types and sizes of hard surfacing electrodes and rods. (158)

Fusion Coatings. Michigan Chrome & Chemical Co., 6 pp, illus. Information on small particle size plastics powders for use in fluidized bed coatings. Information also on equipment for fluidized bed coating. (159)

Silicone Coating. Midland Industrial Finishes Co., 4 pp, illus. Properties, application data, corrosion resistance and uses of a silicone coating. (160)

Metal Cleaners. Northwest Chemical Co., 4 pp. Information on immersion, electrolytic and spray cleaners for die castings, steel, copper and aluminum. (161)

Ultrasonic Cleaning. Oakite Products, Inc., 4 pp, illus., No. 16A. Information on how the ultrasonic cleaning process works, parts most suitable, efficient use of equipment, and available cleaning solutions. (162)

Plastisols, Organisols. Reynolds Chemical Products Co., Div. of Stubnitz-Green Corp., 8 pp, illus. Information on plastisols and organisols used as coatings for paper, steel, bottles, gloves, rope, wire and plating racks. (163)

Removable Coating. Turco Products, Inc., 2 pp, No. 67. Describes a solvent or alkali removable coating for in-shop protection of metallic and nonmetallic surfaces during storage, forming and fabricating operations. (164)

Vinyl Coatings. U. S. Stoneware Co., Plastics & Synthetics Div., No. 187F-1. Chemical and moisture resistance, adhesive properties and application data for a vinyl coating that is applied by hot spraying. (165)

To get suppliers' free literature use prepaid post card on pp 47 and 48.

Joining & Fastening

Glass-Metal Sealing Alloys. Wilbur B. Driver Co., 4 pp. Composition, properties and uses of three glass-to-metal sealing alloys. (166)

Increasing Fatigue Life of Bolts. Elastic Stop Nut Corp. of America, 32 pp, illus, No. 5930. Discussion of fatigue and its significance with respect to threaded high tensile fasteners, and methods of increasing and controlling fatigue life. (168)

Screws. Russell, Burdsall & Ward Bolt & Nut Co., 8 pp, illus. Advantages and specifications of Spin-Lock screws available in hex, pan, truss or flat heads. (171)

Speed Nuts. Tinnerman Products, Inc., 18 pp, illus., No. 353. Seventeen case histories describe assembly saving achieved through the use of Speed Nut mechanical fasteners. (173)

Nylon Screws. Weckesser Co., 3 pp, illus. Installation data for black nylon screws and nuts. (176)

Methods & Equipment • Testing

Testing Machines. American Machine & Metals, Inc., Riehle Testing Machines Div., 40 pp, illus. Information on power testing machines, indicating systems, and a wide range of accessories and instrumentation. (177)

Safety Tools. Ampco Metal, Inc., 24 pp, illus. Information on pliers, wrenches, chisels and 400 other safety hand tools. (178)

Measuring Surface Roughness. Micrometrical Mfg. Co., 12 pp, illus., No. 600. General characteristics, specifications, advantages and other data on a line of equipment used to measure surface hardness. (179)

Electronic Testing Machines. Tinius Olsen Testing Machine Co., 40 pp, illus., No. 54. Operating data and specifications for standard electronic physical testing machines from 500 to 1,000,000-lb capacity. (180)

Wax Injection Presses. Alexander Saunders & Co., 9 pp, illus., No. WP 57. Dimensional data, specifications, features and prices of wax injection presses. (181)

Compacting Presses. F. J. Stokes Corp., 4 pp, illus., No. 123. Complete specifications for a line of single punch and rotary presses. (183)

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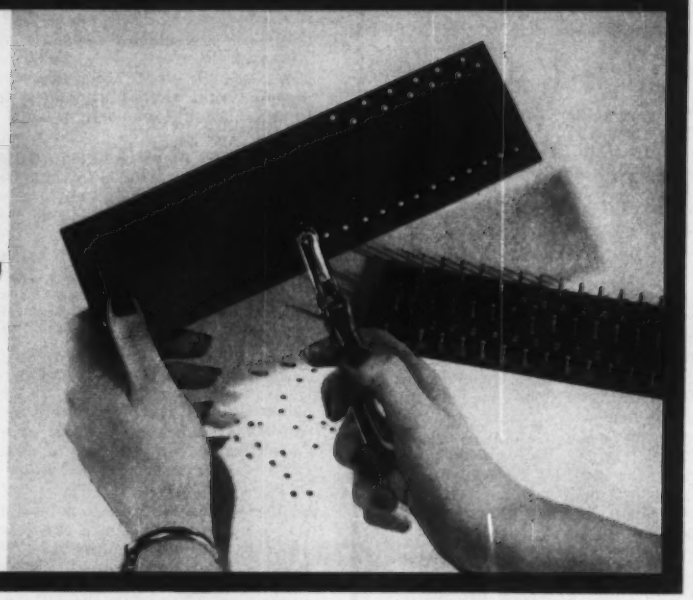

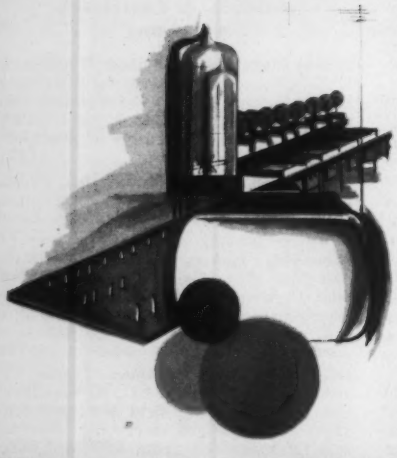

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PAGE NOS.

Adhesives 96, 243, 246
Aluminum and its alloys.....99-100

Bonding process 276
Brazing alloys 270
Brazing fluxes 71

Carbon, graphite 24, 30, 193, 196, 198, 248
Casting alloys 2, 174, 259
Castings 217, 226, 250, 268, 269
Centrifugal 190, 201, 245
Continuous 99-100, 177
Die 2, 22, 108-109, 238, 259
Heat and corrosion resistant. 33
Permanent mold 225, 240
Plaster mold 248
Sand 34-35, 201
Shell mold 201, 225
Ceramics ..76, 172, 191, 216, 272, 280
Ceramoplastics 25
Clad metals 46
Cleaning, ultrasonic 231
Coatings
Ceramic 64
Chemical conversion 120, 205, 232, 251, 277
Diffusion 176
Electroless nickel 263
Metallized 216
Organic 28, 78-79, 175, 276
Plated 98
Sodium nitrite 67
Cold treating cabinets..... 268
Copper and its alloys....inside front cover, 34-35, 99-100, 180, 202, 215, 267

Drawn, pressed parts..... 280

Expanded metals 266
Extrusions
Metallic 201, 233, 280
Nonmetallic 34-35, 112-113, 194, 214, 256, 266, 270

Fabrics, coated 115
Fasteners, mechanical 42, 82-83, 181, 249, 252, 264, 266
Felts 26, 218, 227, 237
Finishing equipment 231
Forgings ..34-35, 37, 43, 204, 265, 272

Gaskets 112-113, 187, 268
Glass 107, 178, 220

Hard facing alloys..... 270
Heating equipment 256, 272
High temperature materials.... 253

Impact extrusions 34-35, 255
Indium and its alloys..... 262
Insulation 187, 223, 281
Iron
Ductile 268
Malleable 102-103

Laminates, plastics.....54, 70, 111, 235, 261, 262
Lead and its alloys..... 241

Magnesium and its alloys...108, 109
Metal forming machines.....92
Metal powder parts.....3, 30, 34-35, 185, 212, 229, 234
Metal powders 3, 82-83
Mica, glass-bonded 25

Packings 112-113, 268
Perforated materials 270
Plastics
ABS 41, 195
Acrylic 203
Cellulose acetate .....88-89, inside back cover
Cellulose acetate butyrate...88-89
Cellulose propionate .....88-89, inside back cover
Diallyl phthalate 56, 261
Epoxies 173, 213, 274
Melamine 58
Phenolics 228, 261
Polyamides (nylon) 72-73, 199-200
Polyesters .....inside back cover
Polyethylenes ..88-89, 95, 118-119, 208-209
Polypropylene 80-81, 93, 257
Polystyrene 72-73, 84-85
Urea 58
Vinyls 97
Vulcanized fibre..... 281
Plastics castings..... 179
Plastics moldings.....34-35, 90, 116-117, 239, 252, 264
Plating processes, solutions..98, 183
Precision parts, metal 224, 258
Precoated & preplated metals 66, 87
Pressure vessels 188

Rings, nonmetallic "O"..... 268
Roll formed parts.....69, 211
Rubber moldings 94, 112-113, 144, 214
Rubbers, synthetic...6, 45, 68, 91, 94, 101, 179, 194, 214, 219

Screw machine parts 186
Sealing alloys, glass-metal..... 221
Seals 112-113, 179, 187, 268
Self-adhesive materials..... 232
Sheet, hot and cold rolled..... 201
Shims 268
Silicones 163-164, 244
Silver and its alloys..... 40
Spinnings 276
Spring materials..... 242
Springs 186
Stampings, punchings.....192, 231
Steel
Bearing 8
Heat and corrosion resistant 4, 32, 66, 196, 197, 271
Specialty 38-39, 82-83, 182, 189
Tool and die .....207, outside back cover
Strip, precision rolled 21, 74-75, 196, 273

Temperature indicators 246
Testing equipment.....168, 222
Testing service 206
Tin and its alloys..... 250
Titanium and its alloys..... 106
Tubed sheet..... 62
Tubing and pipe
Metallic 23, 44, 60, 77, 82-83, 114, 122, 166, 258, 275
Nonmetallic 36, 172, 236

Urethane foam 86, 104-105, 110

Valves, vacuum..... 184

Weldments 116-117
Wire 264, 280
Wire forms 210, 254
Wood 274

X-ray film 247

Note: This index includes all advertisers whose copy was received by closing date, the 5th of the month preceding month of issue. Every effort has been made to insure accuracy, but the publisher does not assume responsibility for errors or omissions.

For free technical literature on all kinds of engineering materials, forms and finishes, see pp 49-53.

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PREVIEW

May 23-26, 1960
Design Engineering Conference and

5th Annual Design Engineering Show

The Conference

The Design Engineering Conference, which runs concurrently with the Design Show, will cover in detail such subjects as new welding processes; fabrication by explosives; high strength steels; nonmetallic structural materials; and the mechanical, power and control aspects of design engineering. (See complete program starting on page 59.)

The Conference sessions, sponsored by the Machine Design Div. of the American Society of Mechanical Engineers, will be devoted to the application of space-age materials, design theory and techniques to new consumer products. Advances made in new materials, fabrication methods, control systems, automation, components and computers will be considered.

In addition to the technical sessions, this year's Conference will again have two general sessions—on the first and last days. The first general session will be devoted to new horizons in engineering design and will cover such things as how new design principles, relationships and formulas can be applied to develop better commercial products. The general session on the fourth day will consider the use of computers in design.

In all, thirty-five speakers drawn from the top level of the nation's design engineers will lead the discussions.

The Show

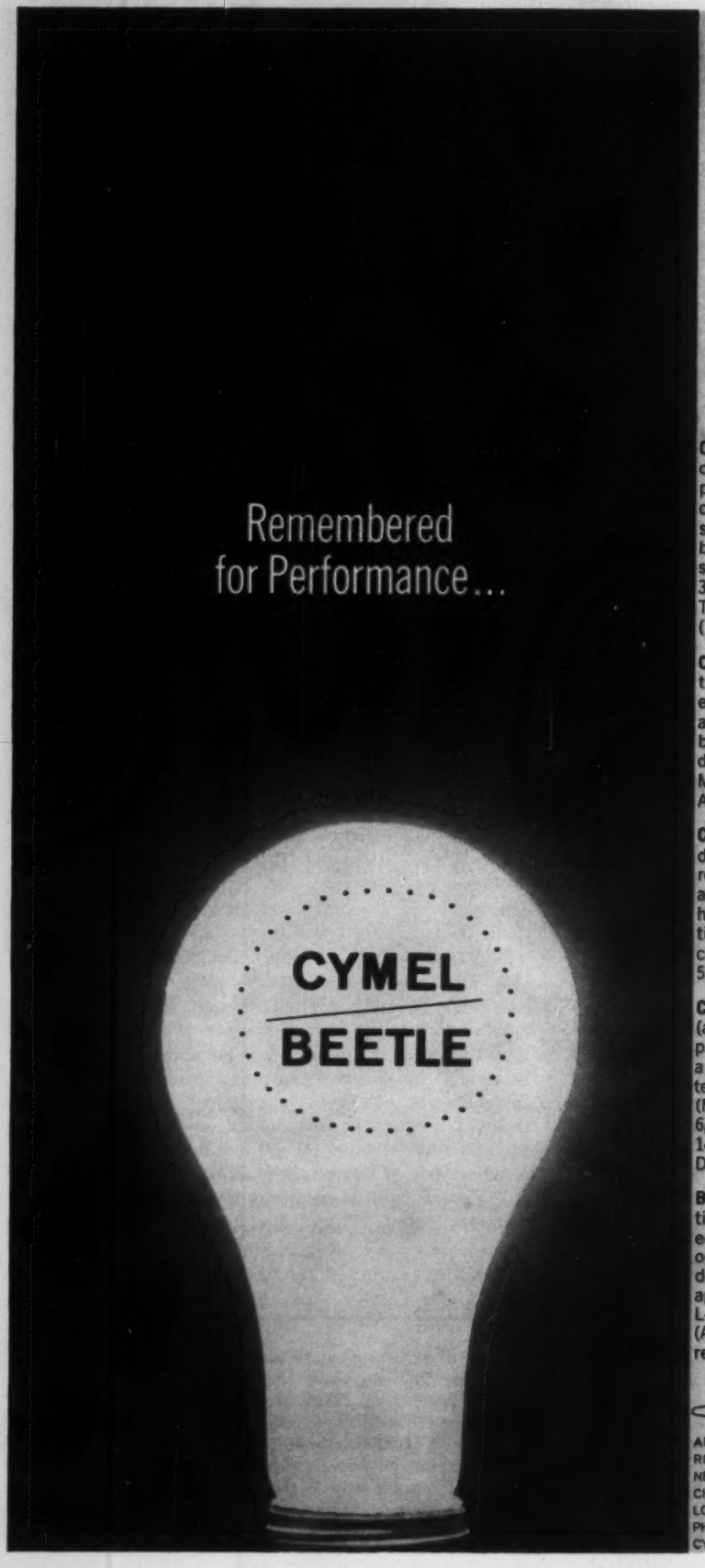
The Design Engineering Show, which has become one of the nation's largest annual industrial expositions, will be even larger and more complete than the extremely successful Show held in Philadelphia last year. Devoted exclusively to the design engineer's needs, the Show will be composed of exhibits demonstrating the latest developments in engineering materials, services, components and product design.

This year's Show, sponsored by Clapp & Poliak, Inc., will concentrate on "Products of the Future." Technical experts from more than 400 leading companies will be on hand to give advice, answer questions, demonstrate new materials and processes, distribute technical data, supply samples of new products, and conduct performance tests. The exhibits have been carefully selected and arranged to provide maximum interest and value for those concerned with the selection and use of metallic and nonmetallic materials; finishes and coatings; forms and shapes; fasteners and adhesives; mechanical, electrical, electronic and hydraulic components; and research, testing and other services for product development. (See complete list of exhibitors starting on page 63.)

Visitors will be especially welcome at the MATERIALS IN DESIGN ENGINEERING booth (No. 2125).

Preview continued on p 59

How to Register—This year's Show carries a registration fee of $2, which can be paid any time during exhibition hours—from 12 noon to 5:30 p.m., May 23-26 (Monday through Thursday)—at the registration desk in the Coliseum, New York. Advance rapid registration forms can be obtained from Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N. Y. Registration for the Conference can be accomplished at the ASME desk in the lobby of the Coliseum from 9:30 a.m. to noon on Monday, May 23, or from 9. a.m. to noon, May 24-26; advance registration forms can be obtained from ASME, 29 W. 39 St., New York. The Conference fee, $5 for ASME members and $10 for nonmembers, entitles registrants to attend all Conference technical sessions, as well as the Design Engineering Show itself. In addition, each registrant will receive copies of all papers delivered at the Conference.



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CYMEL 1077 (alpha cellulose-filled) Additional distinctive properties: Surface hardness, heat resistance, unlimited color range. Typical applications: appliance housings, shaver housings, business machine keys. Specifications: MIL-M-14E—Type CMG (in approved colors); Federal L-M-181 Type 1; ASTM D704-55T Type 1, SP1 SPEC NO. 30026.

CYMEL 1500 (wood flour-filled)—CYMEL 1502 (alpha cellulose-filled) Additional distinctive properties: Good insert retention. Typical applications: meter blocks, ignition parts, terminal strips. Specifications: Cymel 1500 (MIL-M-14E Type CMG, Federal L-M-181 Type 6, ASTM D704-55T Type 6); Cymel 1502 (MIL-M-14E Type CMG, Federal L-M-181 Type 7; ASTM D704-55T Type 7.

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J. J. Chyle—*New Welding Processes.* Current approaches to the problem of welding the newer metals, and an evaluation of pressure welding, fusion welding and brazing. Design of the weldment, cost and service requirements will be considered.

V. Philipchuk — *Metal Fabrication by Explosives.* Latest developments in explosive forming in terms of quality, tolerances and speed.

A. M. Hall—*Use of High Strength Steel.* Properties, available forms, and applications of low alloy hardenable steels, chromium hot work die steels, martensitic stainless steels, precipitation hardenable steels, and cold rolled stainless steels.

W. E. Dirkes—*Nonmetallic Structural Materials.* An approach for obtaining optimum properties of nonmetallic structural materials, especially composite materials. Included are glass-reinforced plastics and adhesives, sandwich construction materials, ablation materials and material systems.

Subjects above will be covered at Materials Sessions.

Program of Technical Sessions

Monday, May 23

9:45 a.m.

General Session (New Horizons in Engineering Design)

Co-Chairmen: DR. HUGH L. DRYDEN, deputy administrator, National Aeronautics and Space Administration; DR. ARTHUR R. KANTROWITZ, director, Avco-Everett Research Laboratory, Div. of Avco Corp.

Panel Members: WILLIAM R. GALL, chief of design section, Reactor Experimental Engineering Div., Oak Ridge National Laboratory; VARICK D. SCHWARTZ, assistant project manager, Army Boiling Water Reactor Project, Combustion Engineering, Inc.; GEORGE P. SUTTON, chief scientist, Advanced Research Projects Agency, Dept. of Defense; ELMER P. WHEATON, vice president-engineering, Missiles and Space Systems, Douglas Aircraft Co., Inc.

Tuesday, May 24

9:30 a.m.—Three concurrent sessions

Materials Session (Fabrication)

Co-Chairmen: HEMENWAY R. BULLOCK, senior engineer, Metallurgical Laboratory, Government Equipment Div., Raytheon Co.; JOHN ALICO, manager, New York Office, Day and Zimmerman.

Speakers:

"New Welding Processes," JOHN J. CHYLE, director of welding research, A. O. SMITH CORP.

"Metal Part Fabrication by Explosives," VASIL PHILIPCHUK, manager, Special Projects Dept., National Northern Div., American Potash & Chemical Corp.

Program continued on p 61

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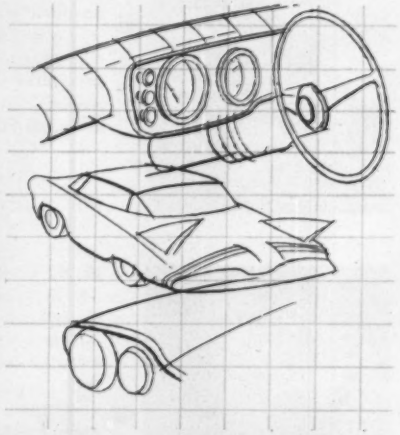

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Power and Control Session (Reliability)

Co-Chairmen: FRANK MCGINNIS, director, Reliability and Quality Control, Sperry Gyroscope Co., Div. of Sperry-Rand; NICHOLAS OSIFCHIN, military development engineer, Bell Telephone Laboratories, Inc.

Speakers:

"Reliability Prediction as a Design Tool," THOMAS C. REEVES, director of product assurance, RCA Defense Electronic Products Div.

"Impact of Reliability on Design," HARRY R. POWELL, member of senior staff, Space Technology Laboratories.

Mechanical Session (Hydraulics)

Co-Chairmen: EDWARD M. GREER, president, Greer Hydraulics, Inc.; JOHN A. FARRIS, manager, engineering liaison, Aircraft Porous Media, Inc., Pall Corp.

Speakers:

"Trends and Factors Influencing Hydraulics," EDWARD BROWN, director of engineering, Machinery Hydraulic Div., Vickers, Inc.

"Hydraulic Fluids—Today and Tomorrow," RICHARD L. LESLIE, supervisor, Fluids and Chemistry Group, Research and Development Dept., Vickers, Inc.

Wednesday, May 25

9:30 a.m.—Three concurrent sessions

Materials Session (Steels, Nonmetallics)

Co-Chairmen: ALBERT R. MEAD, staff engineer, Manufacturing Engineering Dept., Grumman Aircraft Engineering Corp.; EDWARD N. HEGGE, deputy director, Watertown Arsenal Laboratories, U. S. Army Ordnance Arsenal.

Speakers:

"Some Considerations in the Use of High Strength Steels," A. M. HALL, division chief, Battelle Memorial Inst.

"Increasing the Performance of Nonmetallic Structural Materials," W. E. DIRKES, chief, Plastics Branch, Materials Laboratory, Wright Air Development Center.

Power and Control Session (Control Systems)

Co-Chairmen: DR. E. L. HARDER, director, Analytical Dept., Westinghouse Electric Corp.; JOHN T. LYNCH, manager, Electronic Dept., Burroughs Corp.

Speakers:

"Analysis of Control Systems by Analog Computers," WILLIAM E. SOLLECITO, systems analysis engineer, General Engineering Laboratory, General Electric Co.

"Computers in Control Systems," DR. ARTHUR S. ROBINSON, assistant chief engineer for Advanced Electronic Research & Development, Eclipse-Pioneer Div., Bendix Aviation Corp.

Mechanical Session (Automation)

Co-Chairmen: GEORGE F. HAWLEY, director of development and engineering, Automation Engineering Laboratory, Inc.; ALLAN HARVEY, president, Dasol Corp.

Speakers:

"Concept of Modular Design for Mechanized Assembly," A. A. LAWSON, consulting project engineer, Melpar, Inc.

"Basic Design Parameters for Automatic Assembly," ROBERT ESKEN, supervisor, Engineering & Sales Application, Autometrology Section, Sheffield Corp., Sub. of Bendix Aviation Corp.

Thursday, May 26

9:30 a.m.

General Engineering Session: (Computers)

Co-Chairmen: DR. JULIUS S. ARONOFSKY, manager, Electronic Computer Center, Socony-Mobil Oil Co., Inc.; RAYMOND PAYNE, supervisor, Engineering Computer Section, Worthington Corp.

Panel Members: E. F. MAGNUSSON, mathematician, Control Programming, General Engineering Laboratory, General Electric Co.; GEORGE RYCKMAN, supervisor, Data Processing Group, General Motors Research Laboratory, General Motors Corp.; DR. AARON FINERMAN, manager, Digital Computing and Data Processing Div., Republic Aviation Corp.

Exhibitors on p 63

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Exhibitors 5th Annual Design Engineering Show

A-F Engineering 1115
A'G'A Div., Elastic Stop Nut Corp. of America 2216, 2220
AMP Inc. 1303
A. P. M. Corp. 915
Acme Chain Corp. 413
Acme Steel Co. 2235
Aero Div., Robertshaw-Fulton Controls Co. 427
Adams & Westlake Co. 1038
Aeroquip Corp. 1809, 1908
Aetna Ball & Roller Bearing Co. ... 927
Aircraft & Missiles Manufacturing.. 928
Air-Maze Corp. 1134
Alemite Div., Stewart-Warner Corp.. 732
Louis Allis Co. 1712, 1714
Alloy Products Corp. 1240
Aluminum Co. of America 2032
Amco Engineering Co. 337
American Laubscher Corp. 1130
American Metal Climax Corp. 1825
American Nickeloid Co. 2418
American Sealants Co. 1009
American Smelting and Refining Co.. 904
Ampco Metal, Inc. 1612
Amplex Div., Chrysler Corp..... 1125
Anaconda Metal Hose Div., American Brass Co. 1236
Anchor Plastics Co., Inc. 2103
Applied Hydraulics & Pneumatics... 1111
Arch Instrument Co. 222
Arguto Oilless Bearing Co. 525
Armco Steel Corp. 725, 726
Artus Corp. 317
Arvin Industries, Inc. 2219, 2221
Arwood Corp. 117, 119
Associated Spring Corp. 1924, 1926
Atlas Chain & Mfg. Co. 1916-1920
Auburn Mfg. Co. 1505
Automatic Switch Co. 1438, 1439
Automotive Industries 928
Avery Label Co., Decorative Products Dept. 535

Barry Controls Inc. 1624
Battelle Memorial Inst. 328
Morris Bean & Co. 220
Beaver Precision Products, Inc. 236
Beemer Engineering Co. 1127
Bendix Computer Div., Bendix Aviation Corp. 121
Bendix Foundries, Bendix Aviation Corp. 1019
Benton Harbor Engineering Works, Inc. 1635
Beryllium Corp. 342
Binks Mfg. Co. 829
Borg-Warner Corp., Wooster Div.... 2213
Boston Gear Works 1808
Boyle Engineering Laboratory Div., Rotherm Engineering Co., Inc. 2419
W. H. Brady Co. 1734
Brass & Bronze Ingot Inst. 338
Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co. 425
Bristol Co. 430
Brook Motor Corp. 1614
Browning Mfg. Co. 2207
Brush Beryllium Co. 733
Buchanan Electrical Products Corp. 2216, 2220
Bunting Brass and Bronze Co. 931
Burling Instrument Co., Inc. 2100

Camloc Fastener Corp. 1814
Canada, Dept. of Commerce 1304, 1308, 1312, 1320
Carr Fastener Co., Div. of United-Carr Fastener Corp. 530
Casting Engineers, Inc. 2334
Celanese Corp. of America.1239, 1336, 1237
Century Electric Co. 1537, 1539
Cerro de Pasco Sales Corp. 1204
Chain Belt Co. 526
Chart-Pak, Inc. 227
Chemiquip Co. 241

Cherry Electrical Products Corp. 1613
Chicago-Allis Mfg. Corp. 2318
Chilton Co. 928
Chromalloy Corp. 135, 137
Circle F Mfg. Co. 423
Clad-Rex Div., Simoniz Co. 932
Cleveland Graphite Bronze Co., Div. of Clevite Corp. 2204
Cleveland Worm & Gear Co. 1337
Climax Molybdenum Co., Div. of American Metal Climax Inc. 1825
Coating Products, Inc. 2013
Cobalt Information Center 2331
Cobehn, Inc. 412
Colonial Rubber Co. 934
Columbus Coated Fabrics Corp. 533
Columbus Electric Mfg. Co. 429
Commercial Filters Corp. 504
Conneaut Rubber & Plastics Co. 934
Conover-Mast Publications 1225
Continental-Diamond Fibre Corp.... 1540
Control Devices, Div. of Minneapolis-Honeywell Regulator Co. 1202, 1203
Cooper Alloy Corp. 300
Coors Porcelain Co. 1108
Copper & Brass Research Assn..... 529
Corbin Cabinet Lock Div., American Hardware Corp. 214, 216
Corbin Hose Clamp Div., American Hardware Corp. 214, 216
Corning Glass Works 1507, 1509
Cramer Controls Corp. 2333
Crane Packing Co. 512
Crawford Fitting Co. 921, 923
Cullman Wheel Co. 2225
Curtis, Quinlan, Keene & Peck..... 215
Curtiss-Wright Corp., Marquette Metal Div. 329

D. S. D. Mfg. Co. 407
Dayton Rubber Co. 1607
De Laval Steam Turbine Co. 833
Dearborn Glass Co. 431
Deluxe Coils, Inc. 322, 326
Design News 734
Detroit Controls Div., American Radiator & Standard Sanitary Corp.. 1230
Deutsch Fastener Corp. 315
Diamond Chain Co., Inc. 424
Disogrin Industries 219
Dixon Corp. 1206
Dixon Sintaloy Inc. 2102
Dobeckmun Co., Div. of Dow Chemical Co. 2121
Dodge Mfg. Corp. 1834
Doehler-Jarvis Div., National Lead Co. 2026
Dow Corning Corp. 1915
Drop Forging Assn. 832
Ductile Iron Div., International Nickel Co., Inc. 2000
Duff-Norton Co. 516
E. I. du Pont de Nemours & Co., Inc. Elastomer Chemicals Dept. 1409
Film Dept. 1413
Polychemicals Dept. 1421, 1520
Orchem Dept.—Freon Div. 1502
Durakool, Inc 1708
Durametallic Corp 1012
Dynamic Gear Co, Inc. 1104
Dzus Fastener Co., Inc. 735

Eastman Chemical Products, Inc. Chemicals Div. 1626
Plastics Div. 2004, 2006, 2012
Eaton Mfg. Co. 1337, 1430, 1432, 1437, 1534
Ebert Electronics Corp. 2217
Eclipse Machine Div., Bendix Aviation Corp. 125
Elastic Stop Nut Corp. of America 2216, 2220
Electrical Design News 734
Electrical Manufacturing 1225
Electro Metallurgical Div., Union Carbide Corp. 1408, 1412, 1420

Engineered Plastics, Inc., American Sinterings Div. 1535
Engineered Precision Casting Co. .. 909
Enjay Co., Inc. 522, 524
Eriez Mfg. Co. 1114
Ethylene Chemical Corp. 1028, 1030

Falstrom Co. 1816
Farley & Loetscher Mfg. Co. 405
Farval Corp. 1337
Fasson Products 218
Fay-Garrettson Inc. 140
Faultless Caster Corp. 2202
Fawick Airflex Div., Fawick Corp. 1136, 1138
Fenwal Inc. 1621
Fiberfil, Inc. 919
Flexonics Corp. 2421, 2423
Florida Development Commission..204, 203
Foote Bros. Gear and Machine Corp. 828
Franklin Electric Co., Inc. 1705, 1707
H. B. Fuller Co. 411

Garlock Packing Co. 2206
E. D. Geoffrey Garth and Asso..... 1031
Gast Mfg. Corp. 925
General Controls Co. 1608
General Electric Co. 1724, 1726, 1728, 1730
General Fireproofing Co. 2212
Glass Laboratories, Inc. 1107
B. F. Goodrich Aviation Products, Div. of B. F. Goodrich Co. 1403
Graham Transmissions, Inc. 835
Grand Sliding Mechanism Inc. 312
Greene, Tweed & Co. 336
Gries Reproducer Corp. 2435
Groov-Pin Corp. 2330

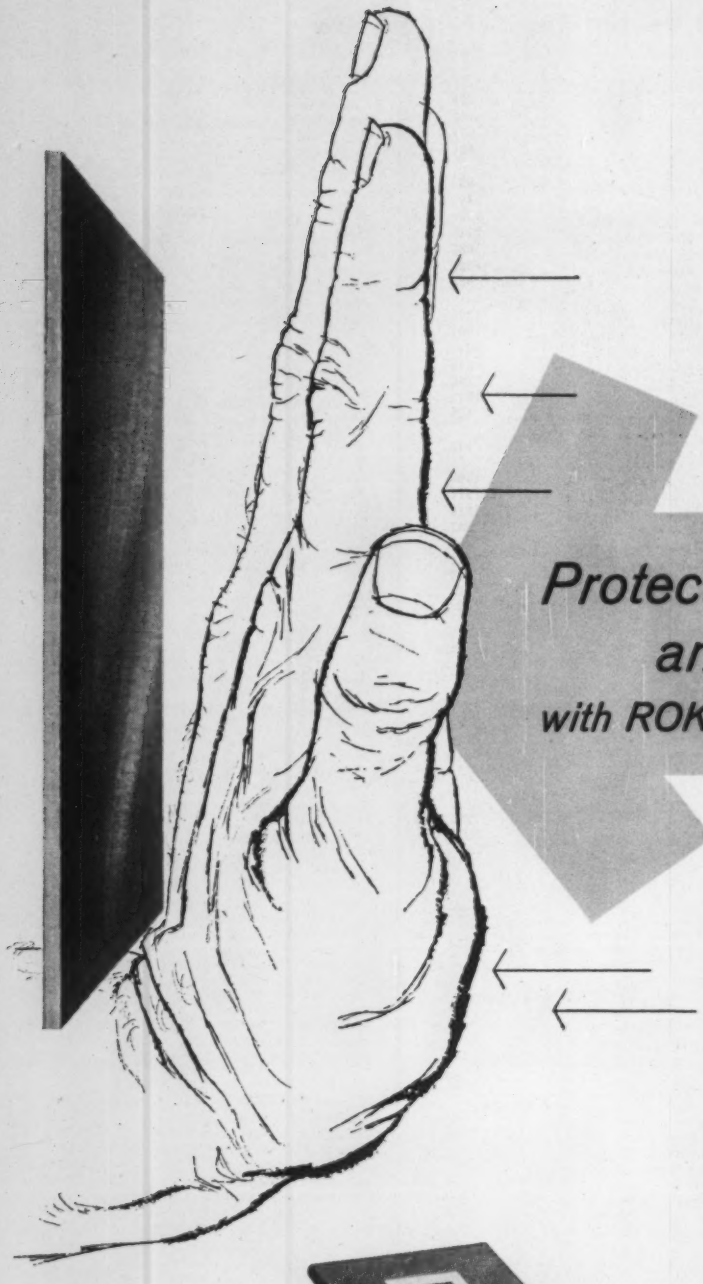
HPL Mfg. Co. 1022, 1024
Hamilton Mfg. Co. 2230
Handy & Harman 1715, 1717
Hansen Mfg. Co. 628
Hartford Steel Ball Co., Inc. 1026
John Hassall, Inc. 1639
Haynes Stellite Co., Div. of Union Carbide Corp. 1408, 1412, 1420
Heim Co. 2113
Heli-Coil Corp. 1828
Hevman Mfg. Co. 1217
Hilliard Corp. 1905
Hitchiner Mfg. Co., Inc. 1231
Hoke, Inc. 1536
Hoover Ball and Bearing Co. 426
E. F. Houghton & Co. 1207, 1209
Hungerford Plastics Corp. 1205
Hunter Spring Co. 1512
Hydroforming Co. of America, Inc... 1631

Illinois Tool Works 1629, 1631
Imperial Brass Mfg. Co. 1606
Industrial Equipment News 1137
Industrial Publishing Corp. 1111
Industrial Research 1625
Industrial Tectonics, Inc. 1404
Instrument Specialties Co., Inc..... 2426
International Nickel Co., Inc....1815, 1819
International Packings Corp. 1309
Iron Age 928

Janette Electric Mfg. Co. 626
Janney Cylinder Co. 500
Johnson Bronze Co. 1531
Jones & Laughlin Steel Corp., Stainless & Strip Div. 510

Kaiser Aluminum & Chemical Sales, Inc. 2005, 2007
Kaydon Engineering Corp. 2429
Kennametal Inc. 1305
Keystone Bolt and Nut Corp. 401

Exhibitors continued on p 65



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Exhibitors *continued*

L & L Mfg. Co. 1823
Laminated Shim Co., Inc. 1221
Lamson & Sessions Co. 2002
Lancaster Glass Corp. 1342
Landis and Gyr, Inc. 1830
La Salle Steel Co. 1321
Lead Industries Assn. 632
Lear, Inc., Instrument Div. 339
Lee Spring Co., Div. of Leetronics, Inc. 1109
Lehigh Chemical Co. 1500
Leiman Bros., Inc. 1630
Licon Div., Illinois Tool Works..1629, 1631
Lignum-Vitae Products Corp. 2417
Linemaster Switch Corp. 1224
Link-Belt Co. 2105, 2107
Lofstrand Co. 2433
Lord Mfg. Co. 1105
Lovejoy Flexible Coupling Co. 1504

MM Enclosures, Inc., affiliated with A&P Metal Products Mfg. Corp.... 2335
Machine Design 1216, 1220
Mac-It Parts Co. 1604
MacLean-Fogg Lock Nut Co..... 1121
Malayan Tin Bureau 2430
Mallory-Sharon Metals Corp. 510
Marbon Chemical Div., Borg-Warner Corp. 728
Marlane Development Co., Inc 320
Martin Engineering Co. 1903
Masland Duraleather Co. 1912
Master Etching Corp. 417
MATERIALS IN DESIGN ENGINEERING... 2125
Matthiessen & Hegeler Zinc Co. 314
Maurey Mfg. Corp. 2317
Mayline Co., Inc. 1615, 1617
McGill Mfg. Co., Inc. 1907
Mead Specialties Co. 1401
Mechanical Rubber Products Co..... 309
Mechanite Metal Corp. 2226
Metal Powder Industries Federation 1525, 1527
Metal & Thermit Corp. 332
Micro Switch Div., Minneapolis-Honeywell Regulator Co. 1202, 1203
Miller Electric Co. 1541
Minnesota Mining and Mfg. Co. 1718, 1720
Mobay Chemical Co. 1129, 1135
Modern Industrial Plastics, Inc. 1034
Moeller Mfg. Co. 313
Samuel Moore & Co. 104, 106
Morse Chain Co., a Borg-Warner Industry 1931
J. Frank Motson Co. 901
Mueller Brass Co. 1405
Mycalex Corp. of America 1400

National Beryllia Corp. 308
National Tube Div., United States Steel Corp. 2104, 2106, 2112
National Vulcanized Fibre Co. 1913
New Departure Div., General Motors Corp. 633
New England Laminates Co., Inc.... 1627
New Hermes Engraving Machine Corp. 1214
Newark Wire Cloth Co. 2233
Nicad Sealed Cell Div., Gould-National Batteries, Inc. 311
Nice Ball Bearing Co. 2321
C. A. Norgren Co. 918
Nylok Corp. 139

Ohio Knife Co. 929
Ohio Seamless Tube Div., Copperweld Steel Co. 629
Olin Mathieson Chemical Corp. 729
O'Neil-Irwin Mfg. Co. 1402
Orange Roller Bearing Co., Inc..... 1636
O'Sullivan Rubber Corp. 2420
Owens-Corning Fiberglas Corp. 2015
Ozalid, Div. of General Aniline & Film Corp. 1027, 1029

Painut Co. 306
Panduit Corp. 409
Park Nameplate Co., Inc. 911
Parker-Hannifin Corp. 1339, 1436
Parker-Kalon Div., General American Transportation Corp. 635
Patron Transmission Co., Inc. 1440
Penn Engineering & Mfg. Corp..... 1023
Penn Metal Co., Inc. 2416
Pennsylvania Fluorocarbon Co., Inc.. 1032
Penton Publishing Co. 1216, 1220
Permacel, Inc. 933
Pic Design Corp., Subsidiary of Benrus Watch Co., Inc. 1208
Plan Hold Corp. 1001
Plastics World 1211
Poloron Products, Inc. 518
Polygon Plastic Co. 230
Polymer Corp. 1513
Poole Foundry & Machine Co. 428
H. K. Porter Co., Inc., Riverside-Alloy Metal Div. 142
Potter & Brumfield, Div. of American Machine and Foundry Co. 1503
Power Transmission Design 1111
Precision Metal Molding 1111
Precision Metalsmith Inc. 231
Precision Specialties, Inc 301
Pressco Casting and Mfg. Corp. 1302
Product Design & Development 304
Product Engineering 1524
Purchasing News 734

Ramsey Corp., Subsidiary of Thompson Products, Inc. 2436
Randall Graphite Bearings, Inc. 914
Raybestos-Manhattan, Inc.....1810, 1812
Reed & Prince Mfg. Co. 1501
Reinhold Publishing Corp., Book Div. 2125
Reliance Electric & Engineering Co.. 2023
Republic Steel Corp. 2131
Revere Copper & Brass, Inc. 1102
Reynolds Metals Co. 1921, 1925
M. H. Rhodes, Inc. 2231
Riegel Paper Co. 1605
Riehle Testing Machines Div., American Machine and Metals Inc. 232
Rigidized Metals Corp. 1122
Robin Products Co. 333
Roehlen Engraving Works 1227
Rogers Publishing Co., Technical Services Div. 334
Rohm & Haas Co. 2116
Roller Bearing Co. of America..... 1530
Rollway Bearing Co., Inc. 419
Roper Hydraulics Inc. 935
Rosan, Inc. 1215
Rotherm Engineering Co., Inc. 2419

SKF Industries, Inc. 1932
Saginaw Steering Gear Div., General Motors Corp. 1508
Sanders Asso., Inc. 2215
A. Schrader's Son, Div. of Scovill Mfg. Co., Inc. 1831
Scully-Jones & Co. 122
Sealol Corp. 1340
Screen Products Co. 913
Shakeproof Div., Illinois Tool Works 1629, 1631
Sier-Bath Gear and Pump Co., Inc... 2031
Sifco Metachemicals Inc. 320
Sigmamotor, Inc. 2315
Simmons Fastener Corp. 2434
Simplatrol Products Corp. 2415
Skinner Electric Valve Div., Skinner Chuck Co. 1813
Snap-Tite, Inc. 825
Snow Nabstedt Gear Corp. 1709
Sola Electric Co., Div. of Basic Products Corp. 905
Southco Div., South Chester Corp.... 1210
Space/Aeronautics 1225
Space Components, Inc. 340
Spaulding Fibre Co., Inc. 1016
Spencer Chemical Co. 624

Spiroid Div., Illinois Tool Works 1629, 1631
Stacor Equipment Co. 2322, 2326
Stahlin Bros., Inc. 2003
Standard Pressed Steel Co. 2124
Star Expansion Industries Corp..... 1234
Sterling Precision Corp. 2319
Edwin B. Stimpson Co. 235, 237, 239
Stokes Molded Products, Div. of Electric Storage Battery Co. 920
Stow Mfg. Co. 1011
Stratoflex, Inc. 1300
Superite Instrument Corp. 414
Superior Tube Co. 2020
Sweet's Catalog Service, Div. of F. W. Dodge Corp. 2130
Sylvania Electric Products Inc. 1521
Synthane Corp. 1126
Syntron Co. 2105, 2107

Tann Bearing Co. 1018, 1020
Taylor Devices, Inc. 1116
Thomas & Betts Co., Inc. 1106
Thomas Flexible Coupling Co. 1600
Thomas Publishing Co. 1137
F. D. Thompson Publishing Co. 229
Thomson Industries, Inc. 2115
Judson L. Thomson Mfg. Co. 625, 724
Arthur Tickle Engineering Works, Inc. 1901
Tinnerman Products, Inc. 1226, 1228
Titeflex, Inc. 408
Toyad Corp. 1515
Tubular Rivet & Stud Co. 238, 240

Union Carbide Corp. 1408, 1412, 1420
Union Carbide Plastics Co., Div. of Union Carbide Corp. 1408, 1412, 1420
Unitech Corp. 416
United Shoe Machinery Corp. 924
U. S. Electrical Motors, Inc. 1704, 1706
United States Plywood Corp. 1117
United States Rubber Co., Mechanical Goods Div. 1324
Royalite Div. 1324
United States Steel Corp. ..2104, 2106, 2112
U. S. Stoneware Co. 934
Universal Castings Corp. 1632
Universal Drafting Machine Corp. .. 634

Valcor Engineering Corp. 1213
Vanton Pump & Equipment Corp., Div. of Cooper Alloy Corp. 226
Veeder-Root Inc. 2316
Vemaline Products Co. 1139
Vibro-Plus Products, Inc. 2325
Vickers Inc. 1725
Viking Pump Co. 824

Waldes Kohinoor, Inc., Truarc Retaining Rings Div. 2016
John Waldron Corp. 2200
Warner Automotive Div., Borg-Warner Corp. 2213
Warner Electric Brake & Clutch Co. 1004, 1006, 1010
Waukesha Foundry Co. 834
Weatherhead Co., Fort Wayne Div. 1601
Web Controls Corp. 1729, 1731
Weckesser Co. 1124
Welding Design & Fabrication..... 1111
Westinghouse Electric Corp. 325
Westline Products Div., Western Lithograph Co. 2320
Edwin L. Wiegand Co. 2336
Winsmith, Inc. 528
Wittek Mfg. Co. 2422
Wolverine Tube Div., Calumet & Hecla, Inc. 221
T. B. Wood's Sons Co. 1736
Worthington Corp. 316, 318

Zenith Electric Co. 1241
Zero-Max Co., Sub. of Reveo Inc. ... 1640

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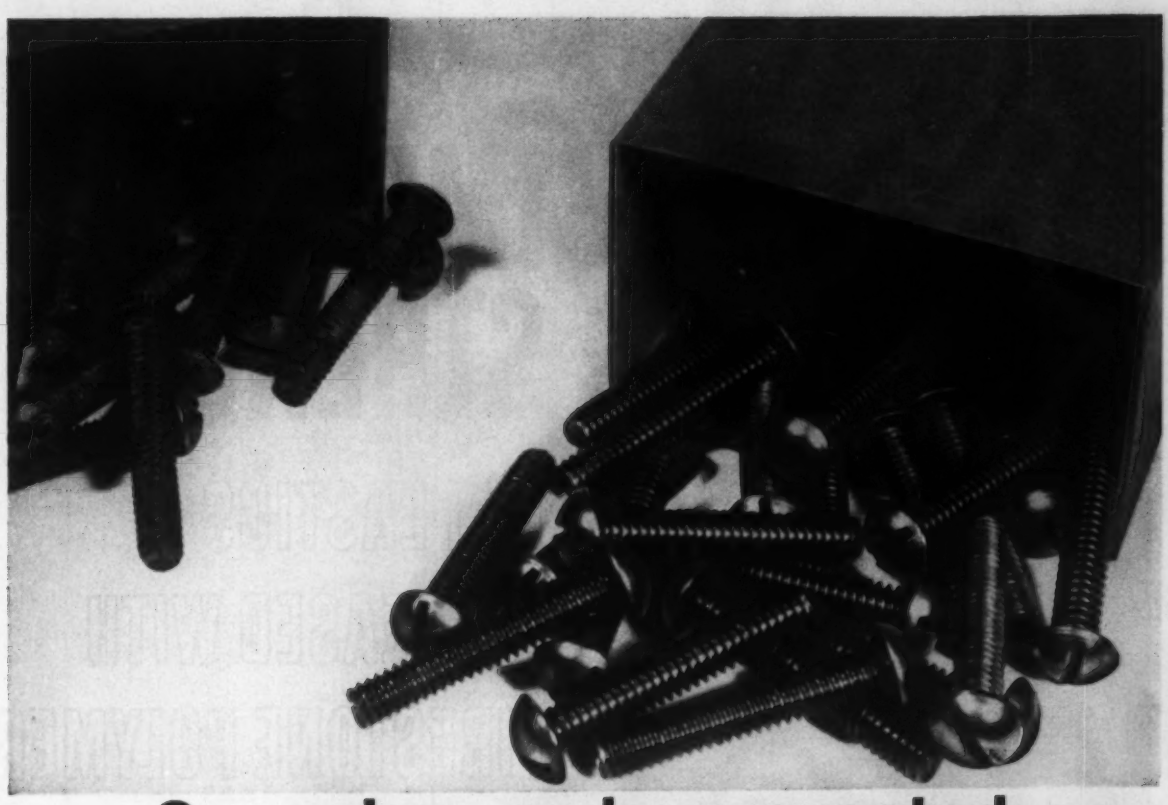

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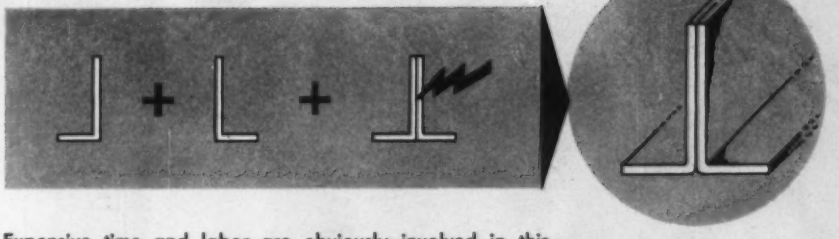

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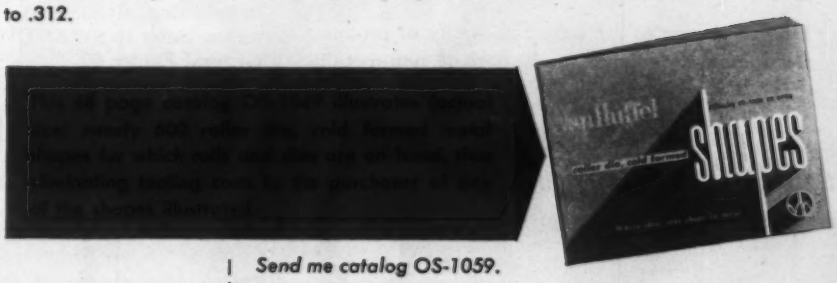

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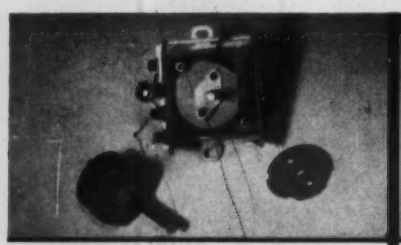

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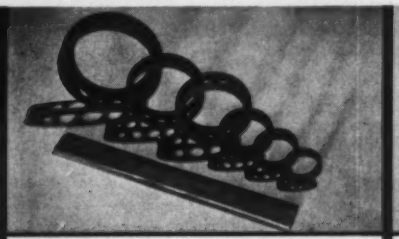

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The correct selection of flux can offer unexpected help in speeding and simplifying production, minimizing rejects and lowering costs in low temperature silver brazing operations. The advantages to be gained by "selective fluxing" are *sufficiently important to warrant careful, thorough study!*

Silvaloy offers the most advanced flux developments in this specialized field. Here, is *a complete line of fluxes* . . . each providing outstanding performance, enabling you to select the correct flux for every possible low temperature brazing operation. The extra efficiency of Silvaloy "Selective Fluxing" is being proved daily on the brazing production lines of the country's leading manufacturers.

Call the Silvaloy distributor in your area for consultation and detailed information or, send for our booklet "A Complete Guide to Selective Fluxing for Low Temperature Silver Brazing."

Silvaloy fluxes are packaged in 65-lb. and 30-lb. drums, 5-lb. wide mouth jars (5 to a carton), 1-lb. and ½-lb. jars. The wide opening of the 5-lb. package makes it a most practical, time saving dispenser that also enables the operator to make use of every bit of flux in the jar.

SEND FOR THIS COMPLETE GUIDE TO FLUXING

ENGELHARD
INDUSTRIES, INC.
AMERICAN PLATINUM & SILVER DIVISION
231 NEW JERSEY RAILROAD AVE. • NEWARK 5, NEW JERSEY

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For more information, turn to Reader Service card, circle No. 455

Joe Foster, President, talks about Foster Grant's unique experience in plastics.

"What we give away is more valuable to our customers than the resins we sell," says Joe Foster.

To put it in a nutshell—we're problem-solvers!

Need a color matched? We can match it precisely—and **fast.** Need marketing advice? Foster Grant's long experience as a molder of finished plastic articles is at your disposal. Or maybe we can help trim your cycling time by mold re-design or machine improvements.

We're **able** to solve our customers' problems because we've piled up a lot of know-how over the years. We had to. Back in the old days, there wasn't any hydraulic molding...there wasn't any lubricated plastic... there wasn't even injection molding in this country. To improve our own operation, we developed all that—and more.

As we led the way, we learned plastics. Inside and out. Today, many Foster Grant advances are standard industry practices. Maybe our unique position as **the only resin supplier with molding experience** can prove as valuable to you as it has to our present customers for styrene monomer, and polystyrene, impact polystyrene and Nylon 6 resins.

Why not call or write us today. Foster Grant Co., Inc., Leominster, Mass., KEystone 4-6511.

FG

FOSTER GRANT

Your Partner in Plastics Progress

Plants in Leominster, Mass., Manchester, N. H., Baton Rouge, La.
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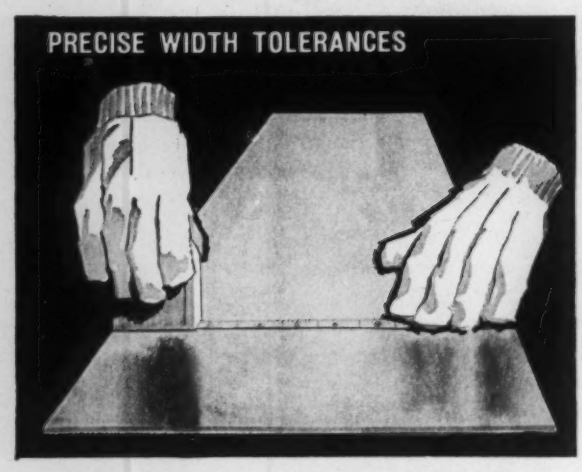
For more information, turn to Reader Service card, circle No. 529

Where precision is important...

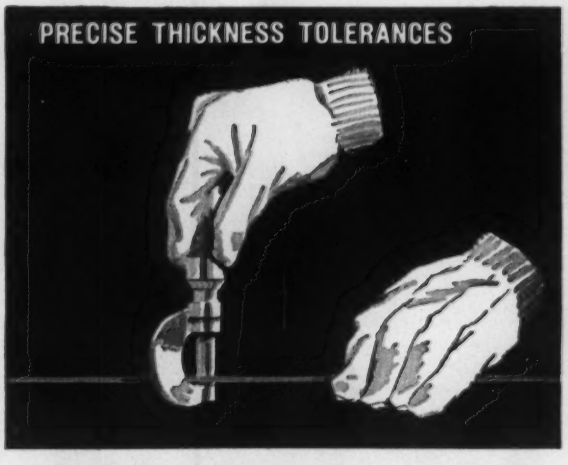
use USS Amerstrip, the "quality-

USS Amerstrip is a specialty product, rolled in quantities that permits production on precision machines, tailored to the customer's product specifications. When you use USS Amerstrip you get seven important "quality controls" not obtainable with other manufacturing methods.

The finish you get on your Amerstrip order has been specially prepared to meet *your* product's needs.



If your fabricating machines require a special width strip that's just what you'll get with Amerstrip. USS Amerstrip can be produced in any width under 24 inches . . . well within exacting tolerance limits.

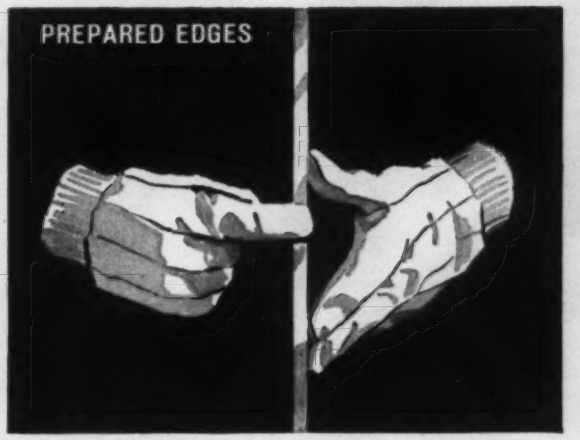


USS Amerstrip can be supplied in the thickness your machines demand. USS Amerstrip is fabricated on large production runs down to thickness tolerances as close as plus or minus .0005 inches.

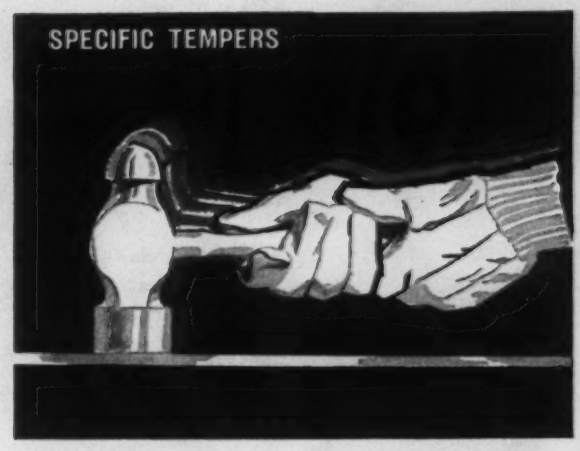
American Steel & Wire representatives are experts in the fabrication and application of USS Amerstrip Cold Rolled Strip. Whenever you have a need or problem involving cold roll let these experts show you how USS Amerstrip can do it better. Get in touch with our nearest representative or write to American Steel & Wire, Dept. 0236, 614 Superior Ave., N.W., Cleveland 13, Ohio.

USS and Amerstrip are registered trademarks

controlled" cold rolled strip steel



Because USS Amerstrip is produced in precision, order-size quantities, it can be supplied with the edge finish you need... square, standard, round, full round or bevel.



Whether your product must undergo a deep draw or other severe forming operation or require a special temper for rigidity, you'll get the exact temper you need when you order USS Amerstrip.

Whatever the size of your order... very large or very small, every coil of USS Amerstrip will be uniform in finish, in temper, in width and thickness. The use of USS Amerstrip will assure continuous production and high yields.

DESIGNED FOR END USE

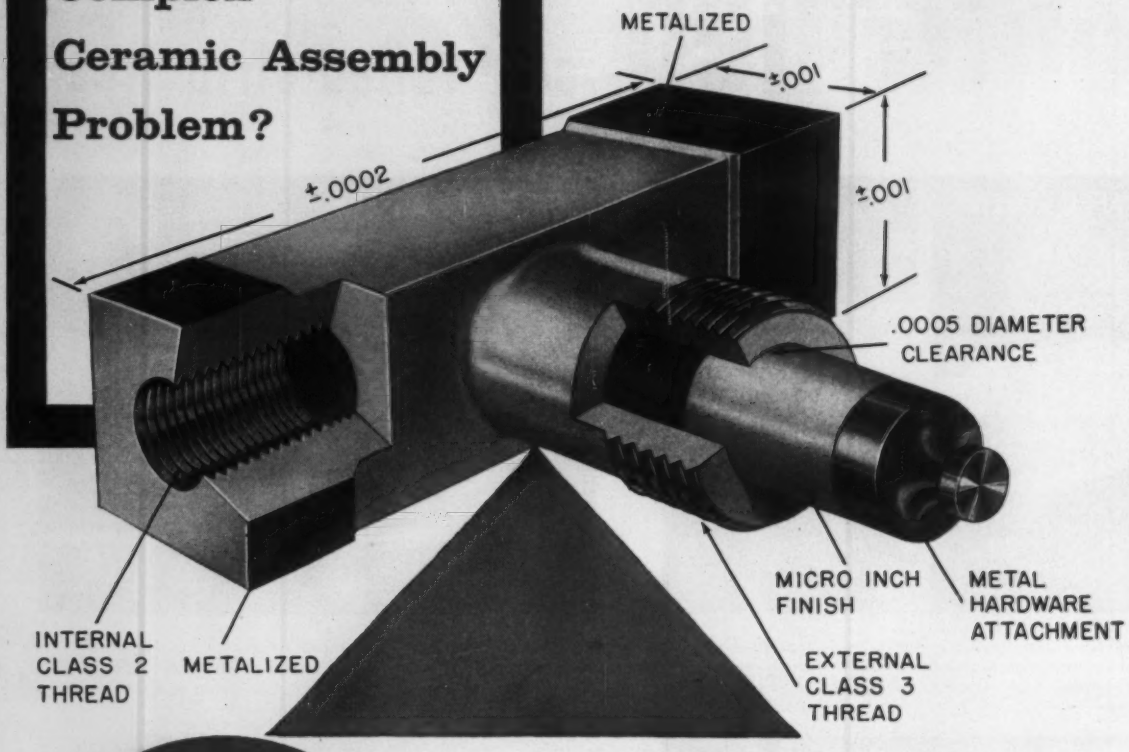
This is really the sum total of all these other advantages. Because USS Amerstrip is "Quality-Controlled," because it is engineered to meet your needs, it assures you smoother, faster operation; a better, more salable finished product.

American Steel & Wire Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
Tennessee Coal & Iron Division, Fairfield, Ala., Southern Distributors
United States Steel Export Company, New York

For more information, turn to Reader Service card, circle No. 465

Complex Ceramic Assembly Problem?



Centralab solves them daily

The pictured unit shows how CENTRALAB can control the manufacturing of precision ceramic-to-metal assemblies to extremely close tolerances, no matter how complex the shape, how intricate the machining. Let CENTRALAB design and production engineering help you take full advantage of the superior electrical and physical properties of High Alumina and Steatite ceramics.

You can achieve improved performance *and* eliminate production assembly problems by utilizing CENTRALAB's know-how in the specialized techniques of close tolerance ceramic-to-metal fabrication. CENTRALAB can handle complex, precision assemblies involving machining of ceramics or metals to ±.0002", metalizing of ceramics, cementing, riveting, soldering, plating, and stamping.

For detailed information on how High Alumina and Steatite ceramics can solve your electromechanical problems, write for free copy of CENTRALAB's new Ceramic Design Handbook (Bulletin No. 42-554), or consult Sweet's Product Design File (folio 4a/ce).

Centralab
CRL
X-5970

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In Canada: P. O. Box 400, Ajax, Ontario

VARIABLE RESISTORS • SWITCHES • CERAMIC CAPACITORS • PACKAGED ELECTRONIC CIRCUITS • ENGINEERED CERAMICS

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WOLVERINE

TEMPERS TUBING TO

CUSTOMER REQUIREMENTS

Do your requirements call for commercial copper or copper alloy tubing in a special temper? One perhaps, which will permit tighter bends, withstand expansion or contribute to better workability?

If you do, Wolverine Tube, Division of Calumet & Hecla, Inc., can meet your needs either from its normal range of tempers or, on your request, will temper your tubing to meet your specifications.

Wolverine's normal range of tempers for commercial tubing includes: ***soft annealed*** (.040 mm. grain size min.) ***light annealed*** (.040 mm. grain size max.) ***light drawn*** (36,000-47,000 psi tensile Rockwell 30T, 30-60) ***hard drawn*** (45,000 psi min. tensile) (Rockwell 30T-55 min.), Drawn General Purpose (36,000 psi min. tensile) Rockwell 30T-30 min. Frequent inspections throughout the production process assure that tempers will meet customer requirements.

Before placing your next commercial tubing order talk to your Wolverine sales representative. He can show you the many ways in which Wolverine Tube can help you obtain maximum value for your tubing dollar. Write, too, for a copy of the Commercial Tube Catalog.

WOLVERINE TUBE

DIVISION OF

Calumet & Hecla, Inc.

DEPT. A, 17258 SOUTHFIELD RD., ALLEN PARK, MICH.

Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

J-9988

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For more information, turn to Reader Service Card, circle No. 447

Q. Which is BEST...

ALKYD...VINYL... or ACRYLIC?

A. NONE-for everything!

New finishes, like new drugs, offer many new advantages. *Also like new drugs, however, none is a cure-all for all needs.*

Neither does successful use in one application assure success in another usage with requirements that differ, however slightly.

Some types of acrylics, for example, give important advantages as automotive finishes where expected durability is a relatively few years, where a high gloss is desirable, and where appearance can be maintained by cleaning and waxing.

It has not been established, however, that acrylics offer similar advantages for aluminum house siding where life expectancies up to 14 years and more have been established for other finishes—and where low gloss and self-cleaning are essential to appearance.

For these reasons, Sherwin-Williams *does not and will not* recommend only acrylics—or alkyds or vinyls—to the exclusion of the others.

Sherwin-Williams manufactures, supplies and maintains continuing research in all three types of product-finish formulations—as well as amines, epoxies, polyesters, latices and many others. Sherwin-Williams *has made and sold* acrylic materials as industrial finishes since 1937, alkyds since 1930, and vinyls since 1936.

Recommendations by Sherwin-Williams Laboratories are not made from the starting point of a raw material, but from the starting point of the *requirements of the end use.* With the largest laboratory facilities in the world devoted exclusively to paint research, this approach has been demonstrated to be consistently successful.

Sherwin-Williams Technicians will be pleased to make recommendations on product finishes for any end use—based on consideration of *all* the requirements of the end use, and on proved performance data. See your Industrial Representative or write The Sherwin-Williams Co., General Industrial Div., Cleveland 1, O.

SHERWIN-WILLIAMS

PRODUCT FINISHES

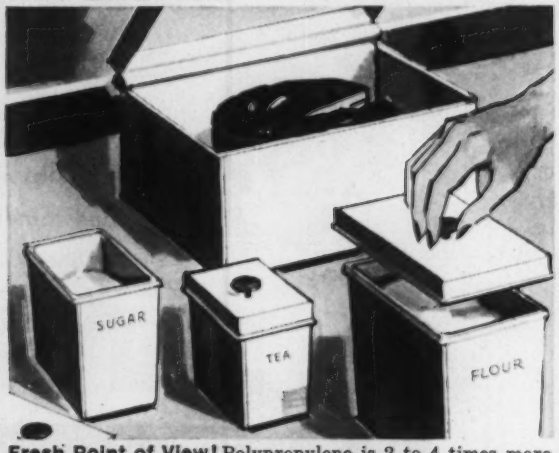
A statement of importance to users of product finishes and coated metals, by The Sherwin-Williams Co.

HOW ALKYDS, VINYLS AND ACRYLICS COMPARE IN IMPORTANT PROPERTIES

PROPERTY	ALKYDS	VINYLS	ACRYLICS
Formability	Good	Superior	Fair
Exposure experience	Excellent	Excellent	Limited
Erosion resistance	Good	Excellent	Unknown
Hardness/flexibility	Good	Excellent	Good
Chemical resistance	Good	Excellent	Excellent
Pressure-marking resistance	Excellent	Excellent	Good
Economy of cost	1 (Lowest)	2	3

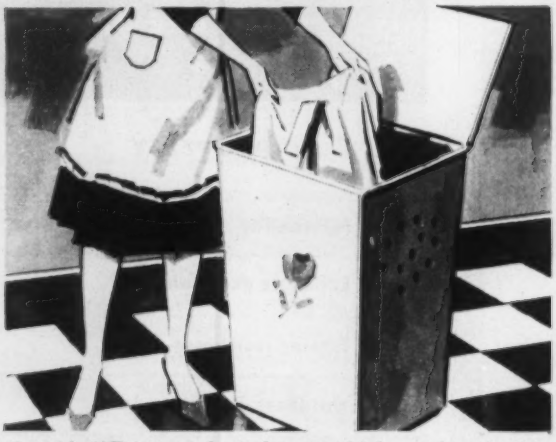
For more information, turn to Reader Service card, circle No. 517

Beats the Heat! Housewares made of Escon get repeated use without warpage. That's because the heat resistance of polypropylene is greater than any other polyolefin. This makes it the desired material for such items as colanders, drainboards, dishpans, tumblers and lighting grilles.



Fresh Point of View! Polypropylene is 2 to 4 times more impermeable to gases and liquids than other thermoplastics. This means freshness stays in, outside elements can't enter. This makes Escon ideal for canister sets, bread boxes and cookie jars—which can be snap-fitted or self-hinged.

Cool Item! Escon is excellent as a food crisper for several reasons. It won't absorb strong food odors and, when properly molded, has the ability to take normal cold without cracking. The design possibilities with versatile Escon are limitless, providing the opportunity to expand existing markets.



New Idea! Escon can be undercut at high speed production cycles. Such items as clothes hampers can be molded in single flat pieces of various colors, then snap-locked for assembly and hinging. This means manufacturers can ship more products in less space . . . retailers will use less storage space, too.

Escon* POLYPROPYLENE CATCHES HER

Important news for molders and designers . . . Escon polypropylene is here! It's the amazing thermoplastic ideally suited to your product needs.

Versatile Escon is easy to work with! It can be injection and compression molded, extruded, thermoformed and heat sealed. The injection molder can start at stock temperatures of 400-450°F., for small items . . . slightly higher for larger ones. In addition, gates and runners for Escon could be of the conventional type, and normal clamp pressures would be employed when molding it. And Escon molds easily—

ENJAY
PLASTICS

EXCITING NEW PRODUCTS

ENJAY COMPANY, INC., *15 West 51st Street, New York 19, N.Y.*

EYE WITH NEW BEAUTY AND VERSATILITY

without warpage! Because of its low density, this amazing thermoplastic resin yields more pieces per pound.

For the designer, the high strength of Escon plus its excellent chemical and abrasion resistance allows accurate production of fine and intricate designs with high surface gloss.

And because polypropylene offers greater heat resistance than any other polyolefin, products manufactured from Escon can be readily sterilized by heat or chemical means. *Trademark

Escon can help you make a better product! For technical assistance or to order Escon, contact the nearest Enjay office.

THROUGH PETRO-CHEMISTRY

ENJAY PLASTICS

Akron • Boston • Charlotte • Chicago • Detroit • Los Angeles • New Orleans • Tulsa • Toronto

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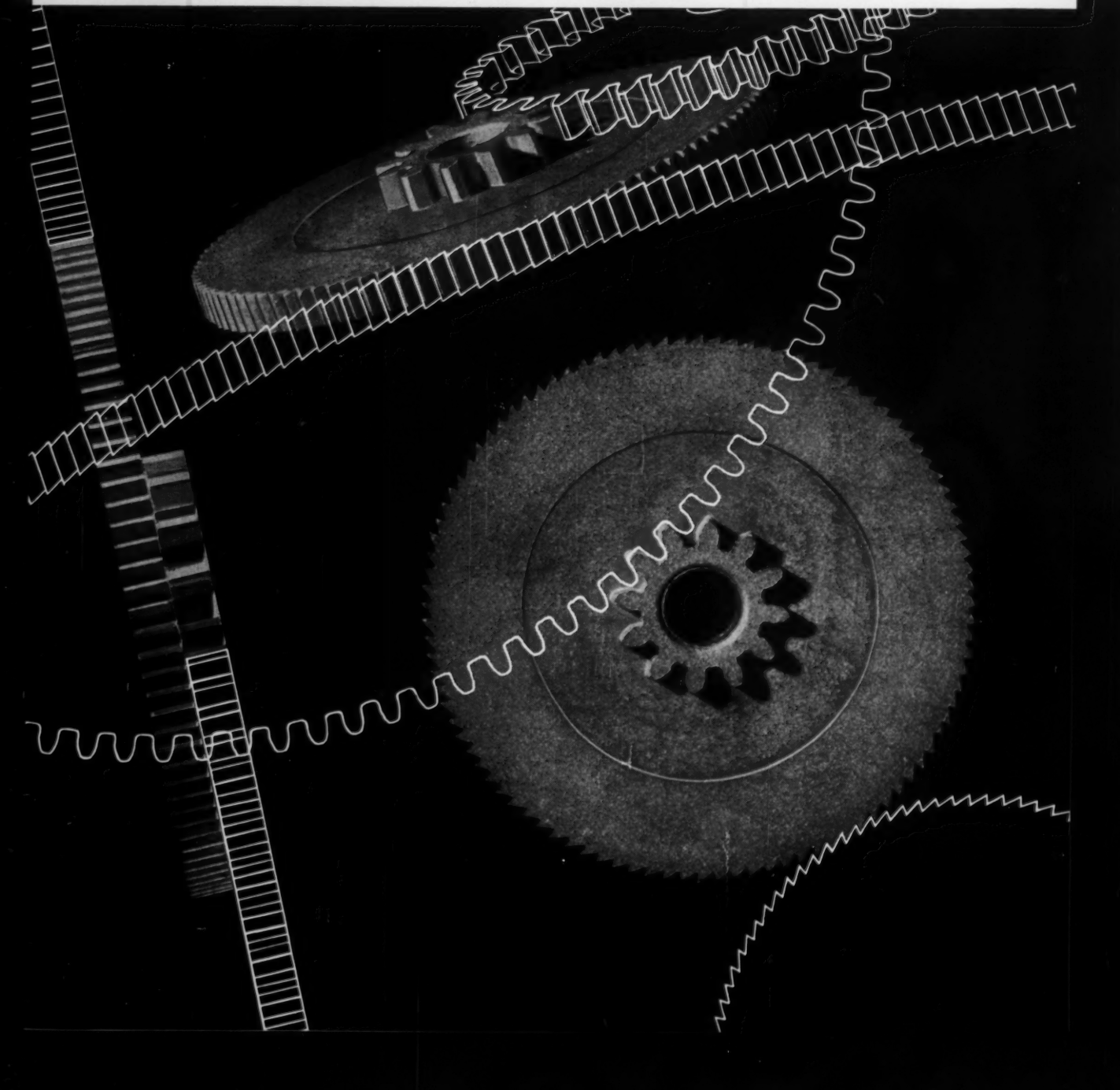
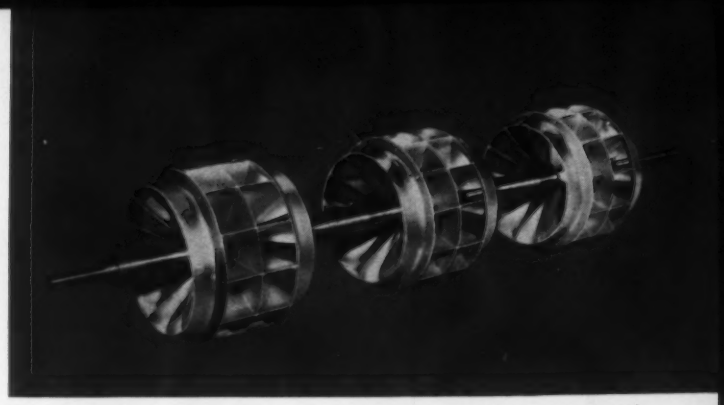
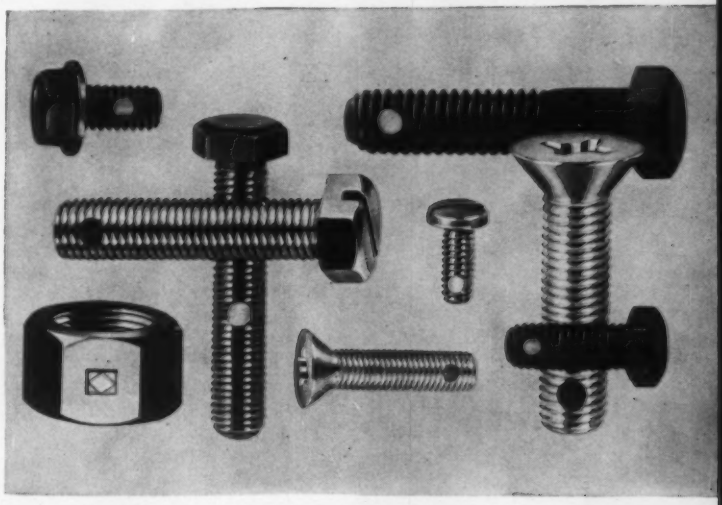
REPUBLIC HIGH-PERFORMANCE PRODUCTS FOR DESIGNERS AND ENGINEERS

REPUBLIC HS6460 HIGH STRENGTH POWDER. This soft, alloy powder can be used to design and produce higher strength structural parts than ever before achieved with ferrous powders. And, at lower manufacturing costs than obtainable with copper infiltration. HS6460 is capable of a minimum tensile strength of 60,000 psi at 6.4 density as sintered—100,000 psi after heat treatment. Excellent carbon compatibility enhances its ability to be heat treated. Chemical composition, physical properties, and test evaluations on HS6460 are contained in Booklet ADV. 1028. Mail the coupon for your free copy.





REPUBLIC ELECTRUNITE® MECHANICAL TUBING was selected as the optimum design material for rotor shafts in scroll-type blowers manufactured by Buffalo Forge Company. ELECTRUNITE shafts—in sizes 3″ to 3¼″ O.D., 8-gage—are bored at each end and a bearing plug inserted. True concentricity of ELECTRUNITE eliminates the need for surface machining . . . assures careful balance and high operating efficiency at speeds up to 2300 rpm. ELECTRUNITE uniformly requires only .015 stock removal from tube ends for positioning of bearing plugs. Mail the coupon for more data on ELECTRUNITE Mechanical Tubing, carbon or stainless steel.



REPUBLIC NYLOK® SELF-LOCKING FASTENERS provide a single-unit answer to vibration, shock, and tension. A permanent nylon insert forces mating threads together for maximum holding power in any position. The relatively inert nylon resists age and moisture—is unaffected by temperature extremes; its natural resiliency permits easy adjustment and repeated use. Republic Nylok Fasteners are non-galling and require no lubricants. Send coupon for descriptive literature; specify bolts or nuts, or both.

REPUBLIC HIGH STRENGTH STEELS eliminate excessive weight . . . add toughness, resistance to abrasion and corrosion. When mobile equipment is designed and engineered to take full advantage of Republic High Strength Steels, weight savings up to 50% are possible, with no sacrifice of performance or safety. High Strength Steels are produced by Republic in four types—"M", "50", "65", "70"—with minimum yield strengths ranging from 50,000 psi to 70,000 psi, and tensile strengths from 75,000 psi to 90,000 psi. Available in a wide range of sizes in bars, plates, sheets, strip. Mail coupon for literature.

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World's Widest Range of Standard Steels and Steel Products

Visit Us At The Design Engineering Show, Booth 2131, New York Coliseum, May 23-26.

REPUBLIC STEEL CORPORATION
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Send more information on:

☐ HS6460 High Strength Powder ☐ Nylok Fasteners
☐ ELECTRUNITE Tubing ☐ Carbon ☐ Stainless
☐ High Strength Steels ☐ "M" ☐ "50" ☐ "65" & "70"

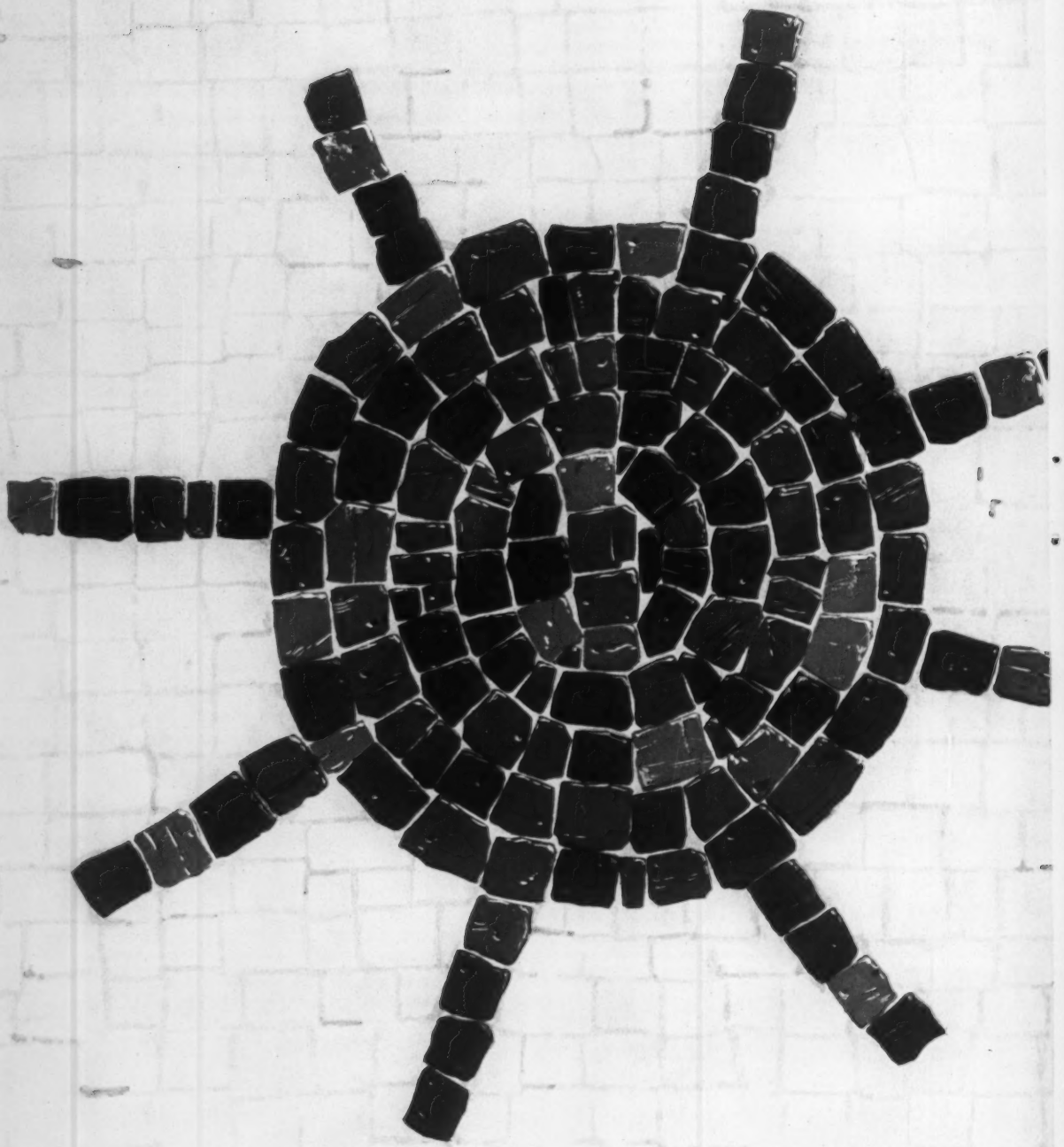
Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

For more information, circle No. 333



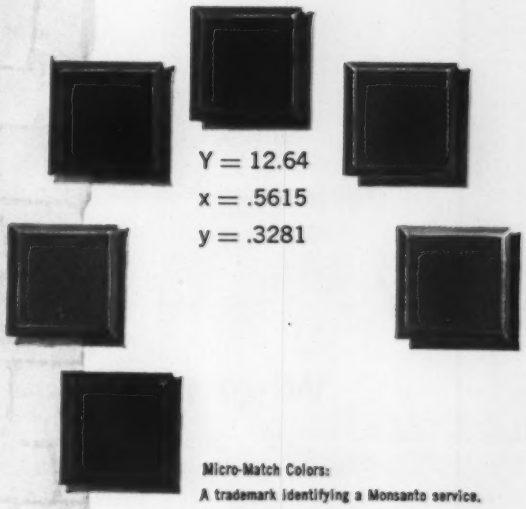
WHAT SIZE RED FOR YOU?

Monsanto Micro-Match Color Service offers you a new reason to explore limitless plastic colors. For the first time, styrene colors can be translated into absolute "sizes"

The Micro-Match Color System has reduced the matching and reproducing of styrene colors from six time-consuming steps with subjective accuracy, to one step that assures objective accuracy and uniformity. In this new system, spectrophotometric data, fed into a specially developed electronic computer, measures colors in precise chromaticity coefficients. Variances too minute for the human eye to distinguish can be determined and corrected. Colors of Monsanto Lustrex® styrene, ordered by coefficient number, will be uniform batch-to-batch, shipment-to-shipment, year after year—even if every sample should be lost or destroyed!

Micro-Match colors join the impressive list of Monsanto achievements in styrene color technology and service, which include the first colored styrene molding powder, the first pelleted colors, the first dry coloring and the first consumer color trend service. These are all part of a continuing program to set new standards of excellence for plastics.

Write for the Micro-Match brochure and call on Monsanto guidance in capitalizing on the rich design possibilities of plastics colors. Monsanto Chemical Company, Plastics Division, Room 716, Springfield 2, Massachusetts.



Y = 12.64
x = .5615
y = .3281

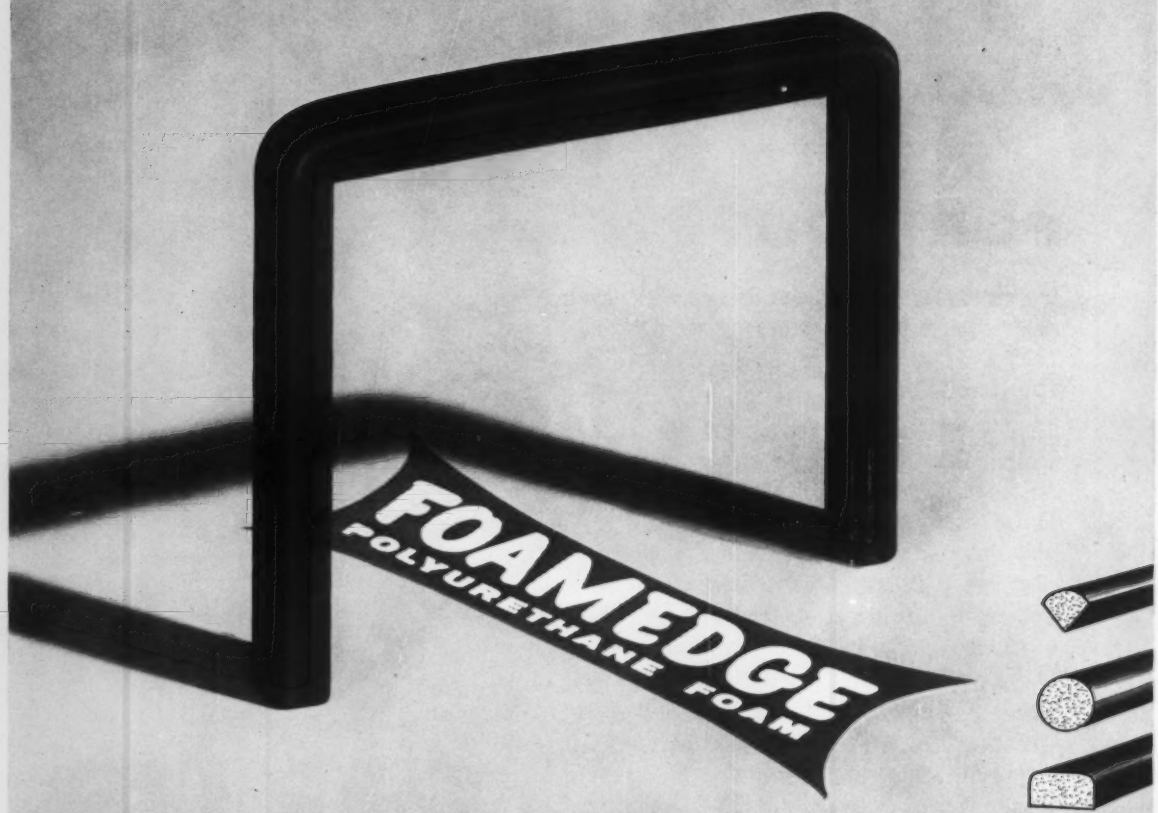
Micro-Match Colors:
A trademark identifying a Monsanto service.

MONSANTO ACTIVATOR IN **PLASTICS**

Monsanto

For more information, circle No. 505

Will this improve your product?



Mold shaped seals and gaskets

Self-formed skin — Continuous lengths

What to do - - with something new?

Here is a modern miracle material in a new form! Already proven as an excellent material for heat insulation, soundproofing, shock absorption, airflow and dust sealing, polyurethane foam is now made in a more applicable form. For the first time, this soft, pliable, durable foam is being conformation molded in continuous lengths—to FIT your needs.

Think what you can do with polyurethane foam in this new form! Strips of soft foam—round, half-round, channeled and special forms. No covering needed, because a slick, smooth outer skin is formed as it is molded. You can have it in any color. Use it in any length, or join the ends for a band—with the joint being the strongest point. Give you an idea?

Write or call for more information

STERLING ALDERFER CO.,

3850 Granger Rd., Akron 13, Ohio

For more information, turn to Reader Service card, circle No. 379

For more information, circle No. 348 ➤

Family living today is richer, easier because of a bright array of appliances, housewares, and hardware that employ one of the breathtaking Nickeloid Metals. Scores of manufacturers already know the extra beauty, the practical utility, and the production economy made possible by these metals with gleaming finishes of chromium, brass, copper, or nickel. Product designers have combined the functional and the decorative to build faster, more profitable sales. Possibilities are endless. Nickeloid Metals, being completely pre-finished, simplify the entire manufacturing process, with greater profit. Let us set up a workshop session with your executives in design, sales, purchasing, and production. We have sales engineers at nearby sales offices qualified to unfold this fascinating picture. Or write us for descriptive catalog.

Nickeloid helps make a family's world

NICKELOID METALS
SINCE 1898
NM

AMERICAN NICKELOID COMPANY, PERU, ILLINOIS · Plants: Peru, Ill., and Walnutport, Pa.

At Eastman

QUALITY CONTROL

is a company's conscience "at work"

Tenite is more than a trade name for Eastman's plastics ...it's a pledge of promised performance

You can measure a company's conscience by the care taken to uphold the quality of its products.

If those products are plastics, uncompromised control is a "must"...for plastics are unique materials. Perhaps no other class of raw materials used by the manufacturing industries has so many variable—yet controllable—physical properties. Flow or moldability, stiffness, heat resistance, weather durability, color, light transmission, hardness...are just a few of the properties that can be custom tailored to meet the needs of a specific application or a specific fabricating procedure. Such flexibility in setting the physical properties of a raw material is an advantage which must be protected by accurate control. For once an acceptable formulation has been created and sold to satisfy both performance and production demands, it is necessary to maintain those properties within extremely narrow limits to assure trouble-free molding operations as well as satisfactory service.

At Eastman, Tenite Quality Control is the vigilant watchdog over the production of all Tenite plastics. This group has the continuing responsibility to conduct all necessary testing to forestall deviation from the specifications set for the many formulations.

So varied and so complete is the testing done by Tenite Quality Control, that this one control section of Eastman requires a staff of over 100 trained personnel.

Acting as a nerve center, sensitive to any factor that could swing a formulation away from its prescribed limits, Quality Control approves or rejects the results in all phases of the production of every pound of Tenite plastic made.

Control of quality begins with approval of the basic raw materials. Even though most of the basic materials that go into Tenite plastics are supplied by other members of the Eastman industrial family, Tenite Quality Control has the final voice in the acceptance or rejection of these materials. At Kingsport, Tennessee, where Butyrate, Acetate and Propionate are made, raw materials such as cellulose esters, plasticizers, colorants and other additives are rigorously tested and graded on their suitability for compounding into clear transparent plastic or into transparent, translucent or opaque colored plastics. Indicative of the care taken to assure shipments of Tenite plastics that are right for each use, is the fact that no order for Tenite Butyrate, Tenite Acetate or Tenite Propionate is filled "out of stock." *Every*

order for these three plastics is made to order as a separate batch, custom-produced to meet the exact specifications requested.

At Longview, Texas, where Tenite Polyethylene in both low- and medium-density grades is produced via continuous processing, Quality Control maintains a constant check of the purity of the ethylene gas as it enters the reactors.

During production of both cellulosic and polyethylene plastics, various tests are conducted at intermediate stages to insure proper control of the chemical reaction. Similarly, after production, samples of the plastics are carefully molded by Quality Control to be sure their forming characteristics are suited to the customer's fabricating equipment. In addition, flow, color, along with physical and chemical stability are also checked. If any special qualities, such as fire retardance or resistance to ultra-violet have been specified, Quality Control runs extra tests on the plastic before shipment to confirm that these requirements have been met.

Color gets particular attention. Over the years, Tenite plastics have won an enviable reputation for accurate color matches. To date, plastics in more than 40,000 different colors and color effects have been produced by Eastman.

Finally, after Quality Control has been satisfied that the Tenite plastic will fully meet all specifications of the customer's order, it is approved for shipment. Even after shipment, Quality Control remains in the picture. Physical samples of all plastics shipped are kept for six months. In addition, all records on the processing of these shipments are retained for five years. Result: Quality Control has a continuing guide for filling subsequent orders with duplications of the original plastic.

Ever since Eastman began producing plastics in 1932, an alert awareness has existed that users of plastics have a critical need for material that is consistent in its performance and handling properties shipment after shipment. If one word were to be singled out to describe the outstanding virtue of Tenite plastics, it would have to be chosen from such adjectives as *uniform, consistent, unvarying, dependable.* But whatever the word, the end-result has been satisfaction for our customers... *and for us.*

And, after all, that's the purpose of having a conscience.

The full story of the detailed testing that underwrites the reputation of Eastman plastics, is told in a 20-page booklet, "QUALITY CONTROL." For your free copy or more information on Tenite plastics, write EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

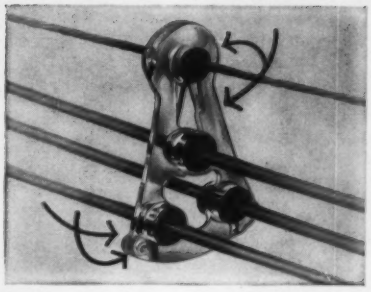
TENITE®

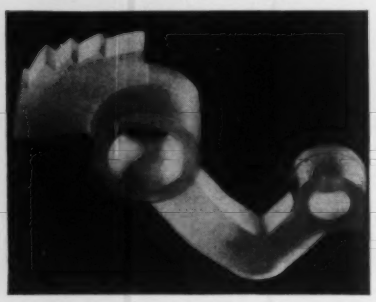
BUTYRATE · POLYETHYLENE · PROPIONATE · ACETATE

Dependable plastics by Eastman

For more information, turn to Reader Service card, circle No. 327

1 Nylon replaces metal in this idling cam made by Chicago Molded for Holly Carburetor. By injection molding it of nylon, CMPC eliminated 3 operations—hardening, stamping, and assembly . . . cut production costs 50%. A unique mold design provides for easy changes in the number and sizes of ratchets at minimum expense. By any measure of value analysis, this is *designing for profit.* Think how this foresight could benefit your product, your profit.





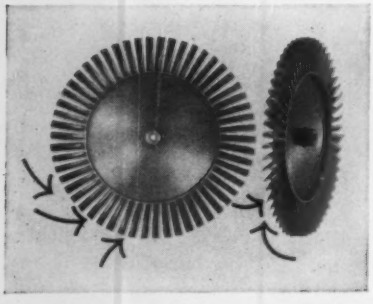
2 This new cable spacer, produced for PLM Products, Inc., speeds installation time on messenger-supported aerial cable systems. Cuts costs for service and utility companies. The unit locks in place automatically—no tools or bolts—no extra pieces to handle or drop. A weather-resistant, extra strength acrylic material was recommended and a unique mold design permits injection-molding all parts in a single shot.

3 This transfer molded part is one of 10 Tormat memory blocks in the Seeburg Selectomatic 200 phonograph. The Chicago Molded body involves closest tolerances at 10 key spots on each side of the blocks. Fine detail and dimensional stability, good dielectric properties and high moisture resistance were basic material requirements met by CMPC. Our engineers can suggest ways to make your products better by designing in plastics . . . *designing for profit.*

5 ways to design for profit with Chicago Molded plastic parts

Photo Courtesy Modern Plastics

4 The Non-Combustible Gratelite Louver Diffuser was molded for Edwin F. Guth Company, St. Louis, This complex piece uses a specially developed fire-resistant urea plastic material that retains required light diffusion properties. This new type louver is dimensionally stable and also dirt-resistant—another example of "know-how" in plastics molding by Chicago Molded.



5 This is the molded plastic turbine fan wheel for the new Sunbeam "Dual De Luxe" Vacuum Cleaner Turbine Brush—first single shot plastic molding of a fan incorporating the turbine principle. Nylon was used for its flexibility and resistance to impact of objects entering the cleaner. Involved also was a complex mold incorporating 56 individual sliding cores. It's another example of designing for profit by Chicago Molded.

CMPC

CHICAGO MOLDED
PRODUCTS CORPORATION
1020F North Kolmar Avenue, Chicago 51, Illinois

For more information, turn to Reader Service card, circle No. 326

Newest best seller...soles of Ameripol Rubber

To rubber soling's well known virtues of durability and economy you can now add another advantage—exceptional appearance and smooth feel. As a result, this new product of Bearfoot Sole Company is enjoying spectacular sales in the quality, dress shoe market.

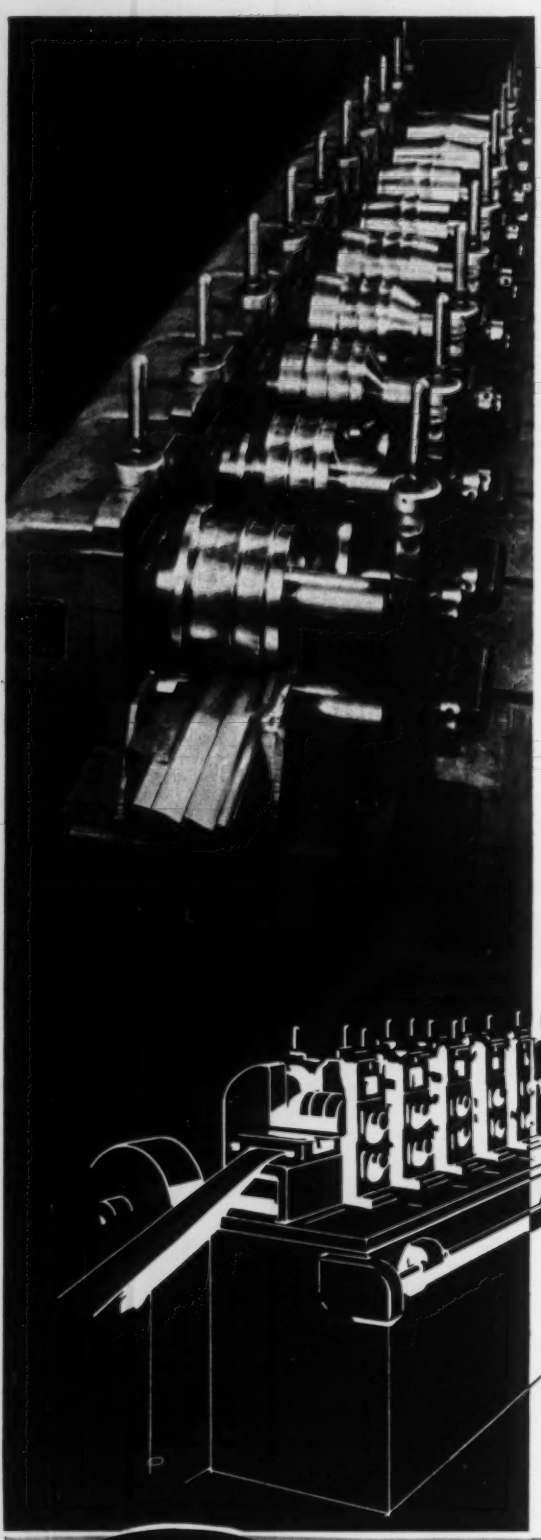
The new look is achieved by the use of advanced finishing techniques with a new rubber polymer—Ameripol 4600. Since the process demands that only a minimum of pigment may be used, the uniformity of color and texture must be inherent in the rubber raw material. Ameripol 4600 consistently meets the stringent requirements—and cuts processing costs in the bargain.

If you make or use rubber products, it's wise to check Goodrich-Gulf. We produce the broadest range of polymers in the industry, and stress the individual technical services that can help *you* make improvements. Contact Goodrich-Gulf Chemicals, Inc., 1717 East Ninth Street, Cleveland 14, Ohio.

Ameripol
THE PREFERRED RUBBER

Goodrich-Gulf Chemicals, Inc.

For more information, turn to Reader Service card, circle No. 475



Yoder Roll-Forming Equipment mass-produces shapes accurately, economically

Yoder Roll-Forming Equipment, even with part-time operation, can effect significant savings in many metal working applications and industries. Shapes, simple or complex, can be quickly and economically produced the Yoder way from a wide variety of flat-rolled coated or uncoated stock . . . in thickness up to ¾ inch . . . in speeds up to 50,000 feet per day.

Yoder engineers flexibility and precision into metal forming operations. For example: many basic shape modifications, such as coiling, welding, notching, ring-forming, perforating, and cutting to length can be simultaneously accomplished with little or no additional labor cost.

Yoder also makes a complete line of Rotary Slitters and Pipe and Tube Mills. Profit from Yoder's years of engineering and service experience, contact your local Yoder representative or send for the Yoder Roll-Forming Manual.

THE YODER COMPANY
5548 Walworth Avenue
Cleveland 1, Ohio

This fully-illustrated 88-page book clearly discusses every important aspect of Yoder Roll-Forming Equipment and methods . . . it's yours for the asking!

ENGINEERING
YODER
MANUFACTURING

COLD ROLL FORMING MACHINES
PIPE AND TUBE MILLS (ferrous or non-ferrous)
ROTARY SLITTING LINES

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Catalin POLYPROPYLENE

. . . a plastic to get steamed up over!

CATALIN POLYPROPYLENE possesses the thermal, mechanical, chemical and electrical properties that make it superlatively suitable for such applications as these handsome, new PRAK-T-KAL* *vaporizers-humidifiers* . . . engineered to operate for as long as 16 hours continuously without refilling.

CATALIN POLYPROPYLENE is exceptionally resistant to heat . . . it retains its high tensile strength and will not distort at elevated temperatures. It is the material of choice for low-cost, durable components in home appliances such as washers, driers, dishwashers. Hospital utensils which must endure steam sterilization maintain their shapes at temperatures as high as 300° F.

Lightest of all plastics, tougher than most, CATALIN POLYPROPYLENE displays a rigid, hard, mar-defying surface with excellent gloss and finish. Pipe, fittings and valves . . . films . . . extruded sheets for forming refrigerator door liners and radio cabinets . . . luggage . . . photographic products . . . endless functional and decorative possibilities open up for this economical, versatile plastic. Inquiries invited.

*Housings molded for Practical Electric Products Corp., L. I. City, N. Y. by Jamison Plastic Corp., N. Bellmore, N. Y.

Catalin Corporation of America Catalin **One Park Avenue, New York 16, N. Y.**

For more information, turn to Reader Service card, circle No. 405

OHIO RUBBER

"CUSTOMEERED* COMPONENTS BASIC TO INDUSTRY"

ORCO IDEA PARTS

cultivate grass-root economy... harvest peak performance

OHIO RUBBER IS THE GOOD SOURCE FOR THE AGRICULTURAL IMPLEMENT MANUFACTURER!

FROM INITIAL CLEARING to final harvest, ORCO IDEA PARTS build-in extra performance, low maintenance for brush clearers, gang plows, planters, cultivators, cotton pickers, hay balers, corn huskers and other agricultural implements. ORCO quality rubber components, functioning as original equipment, are designed for utmost economy —top efficiency.

ORCO "CUSTOMEERING" focuses the full scope of Ohio Rubber's integrated design, research, and practical ingenuity on your component to cut production costs—to deliver a better part.

OVER 75 YEARS of pioneering experience in custom-crafting OEM components of rubber, synthetic rubber, silicone rubber, polyurethane, or flexible vinyl define The Ohio Rubber Company as the industry standard of single source control and responsibility—of product excellence for the agricultural implement manufacturer.

TIRES ARE IMPORTANT TOO! ORCO'S 16-page "Soil King" booklet (Form 429) tells the complete story on tires for agricultural service. Get your free copy of it as well as descriptive folder "ORCO Component CUSTOMEERING" (Form 715) on Ohio Rubber's complete facilities and services for forming rubber.

AG-260

*Trademark of The Ohio Rubber Company

ORCO **THE OHIO RUBBER COMPANY**

General Office • WILLOUGHBY, OHIO • WHitehall 2-0500

A DIVISION OF THE EAGLE PICHER COMPANY

EAGLE PICHER

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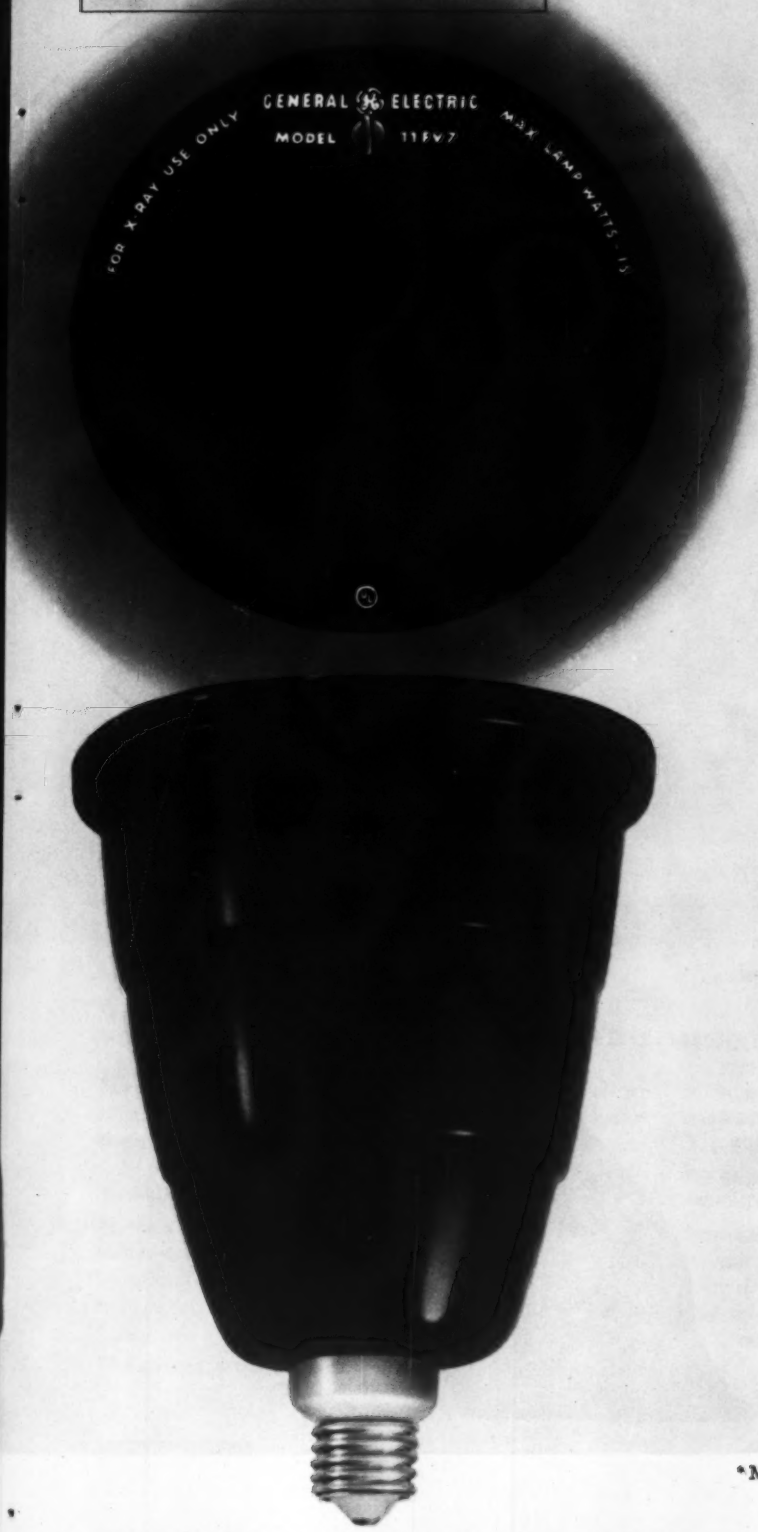
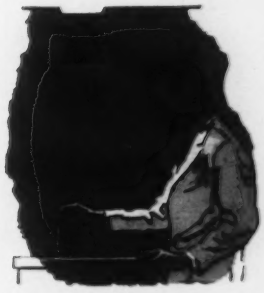
For more information, circle No. 488

NEW DESIGNS IN MARLEX





Housing for G-E darkroom light is thermoformed of heat-resistant MARLEX*

General Electric specifications on this X-ray and fluoroscopic darkroom light called for a rugged and opaque housing that would be unbreakable, corrosion-proof, capable of withstanding incandescent heat, and acceptable for Underwriter's approval. General Electric design engineers found MARLEX high density polyethylene the ideal material . . . both from the standpoint of performance and cost.

These lamp housings, formed from sheets of MARLEX 6002 Resin, fully demonstrate the superior characteristics of this quality plastic for deep-draw thermoforming at economically fast cycle times. In addition, the thermoformed housings are free of warpage and dimensionally accurate so that tinted lenses snap into place and provide a light-tight friction fit.

General Electric chose MARLEX because its superior properties mean both quality and economy. How can MARLEX serve you? It's a material that combines light weight, strength, rigidity, toughness, and resilience with resistance to acids, solvents, alkalies, oils, heat and cold (250° F to −180° F). MARLEX is non-absorbent and waterproof. It can be injection molded, thermoformed, extruded . . . machined, welded, and printed upon. For full details, contact the nearest office listed below.

*MARLEX is a trademark for Phillips family of olefin polymers.

PHILLIPS CHEMICAL COMPANY, Bartlesville, Oklahoma, A subsidiary of Phillips Petroleum Company

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EXPORT: PHILLIPS PETROLEUM INTERNATIONAL CORPORATION • P. O. Box 7239, Panama City, Panama • Sumatrastrasse 27, Zurich 6, Switzerland

PHILLIPS 66 MARLEX

Special Ray-BOND® Adhesive

BONDS GLASS TO PLASTIC

To reduce breakage and assembly time of glass vacuum bottle fillers, The American Thermos Products Company, Norwich, Connecticut, undertook to replace an aluminum cap with a polyethylene protector for the evacuation tip of the glass filler.

The problem was bonding the traction-free polyethylene to the smooth glass surface. Existing adhesives couldn't do the job. R/M adhesive specialists, working closely with Thermos Company engineers, quickly developed a special adhesive.

The result is a superior bonding agent, R/M's new R-84002, for "Mylar," polyethylene, glass and other slick-surface, bond-resistant materials. Based on a thermoplastic synthetic resin, R-84002 has temperature tolerances ranging from −20 to +200°F.

Regardless of your application Ray-BOND adhesives of new or existing formulations can be tailored to your special bonding, laminating, sealing or coating requirement. Your costs are reduced; your production is improved. Let us prove this to your satisfaction. Call on Raybestos-Manhattan engineers today without obligation.

R/M Bulletin No. 700 contains helpful engineering information on Ray-BOND adhesives, protective coatings and sealers, and casting, encapsulating and potting compounds. Write for your free copy.

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ADHESIVES DEPARTMENT, Bridgeport, Conn. • Chicago 31 • Detroit 2 • Cleveland 16 • Los Angeles 58

R/M

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For more information, circle No. 489 ➤

Photographed with the cooperation of Columbus Coated Fabrics Corp., Columbus, Ohio

Lasting and lustrous—because it's made of PLIOVIC!

Surprising as it may seem, you're looking at a fabric supported vinyl upholstery. It's called *Milano* and, for the first time, combines the soft shimmer of moiré silk with the washability, wearability and general durability of vinyl.

There's no single reason for the distinctive eye- and touch-appeal of this upholstery. It results from a combination of fine skills and materials. But among these materials, PLIOVIC, the basic vinyl resin used, plays a key role.

The primary advantages of using PLIOVIC are: 1. It blends readily, fuses at low temperatures, is generally easy to process. 2. It embosses easily and faithfully. 3. It helps assure lasting adhesion to the knitted fabric backing. Other benefits: Excellent heat- and light-stability plus good over-all physical properties.

Improving the appearance and performance of supported upholstery sheeting is but one of many possible uses for PLIOVIC. How can it help your product? For the answer plus full details on PLIOVIC write: Goodyear, Chemical Division, Dept. P-9458, Akron 16, Ohio.

GOODYEAR

CHEMICAL DIVISION

Pliovic—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

Milano—T. M. Columbus Coated Fabrics Corporation, Columbus, Ohio

News about COATINGS FOR METALS

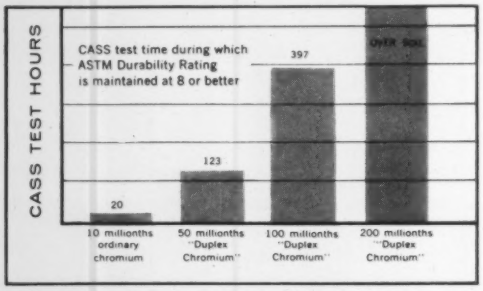
from Metal & Thermit Corporation

The thicker the "Duplex Chromium" ... the longer the plating lasts

The thicker this new, combination decorative chromium plate, the longer the finish lasts. This, in brief, is what accelerated corrosion tests show repeatedly. Increased corrosion resistance always results from thicker deposits of M&T "DUPLEX CHROMIUM"—whether tests are conducted by the CASS (1) or Corrodkote (2) methods.

This pattern of protection is consistent whether panels are steel, or zinc die castings. Note in the graph how the durability of the chromium plate is upgraded by thicker deposits. A thickness of 50 millionths of an inch of M&T "DUPLEX CHROMIUM" delivers a dramatic increase in durability. And a 100 millionths thickness enables samples to survive 100 CASS test hours and still maintain an ASTM durability rating at near the perfect level of 10. This achievement becomes all the more amazing when it is realized that automotive specifications till now only called for decorative chromium plate able to endure 16 hours of CASS.

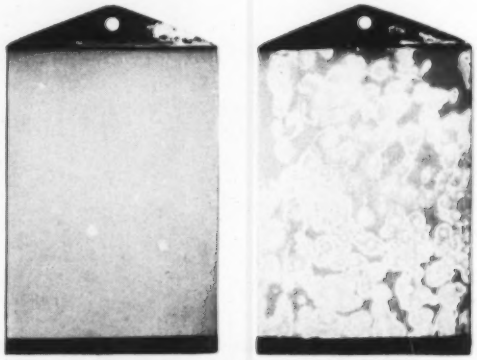
Specifying the additional chromium thickness is a way to add years to the outdoor life of the bright finish. And for the ultimate in performance, M&T "DUPLEX CHROMIUM" now brings within reach of designers a decorative chromium plate that can last as long as they desire.



Graph indicates how corrosion resistance of chromium plate and ability to maintain ASTM durability rating of 8 or better in CASS testing increases with thickness. All test panels had 0.75 mil copper and 0.75 mil nickel undercoats – only the chromium was varied.

A UNIQUE DOUBLE PLATE

M&T "DUPLEX CHROMIUM" consists of a deposit from the Unichrome Crack-Free Chromium bath, topped by a deposit from another special Unichrome SRHS® Chromium bath. The former blocks penetration of corrosives to the undercoats; the latter minimizes the effects of localized corrosion cells resulting from irregularities in the surface of the basis metal.



Left: zinc die cast panels with 0.10 mil "Duplex Chromium" over copper and nickel undercoat, when subjected to 6 cycles of Corrodkote test, still rated 9.

Right: zinc die cast panel with 0.01 mil ordinary chromium over identical undercoats as panel to left rated only 1 after same 6 cycles.

Both of these Unichrome SRHS® (self regulating high speed) baths are ideal for plating thicker chromium. They not only speed production but also simplify it. They give more uniform plate distribution and covering power, so that recesses, too, receive adequately thick deposits.

More data on tests and technology available. Send for your copy.

(1.) Copper-accelerated acetic acid salt spray.

(2.) Standard, uniform highly corrosive slurry applied on test piece, which is then placed in non-condensing humidity cabinet. Each cycle is 16 hours.

coatings and finishes

METAL & THERMIT CORPORATION
General Offices: Rahway, New Jersey

For more information, turn to Reader Service card, circle No. 422

For more information, circle No. 490

SCOVILL® gives you fault-free metals for **high speed** fabrication

Advanced mill processes — Scovill pioneered the CONTINUOUS CASTING of Brass alloys to bring fabricators of Brass Mill Products the new standard of metal soundness and uniformity made possible by this unique process. Other more recent new mill installations at Scovill include precision-controlled Aluminum rolling mills; the advanced Sendzimir Mill for extra-close-tolerance sheet and strip; the World's largest vertical tube extrusion press, with automatic induction billet-heating equipment, as well as one of the Industry's newest and largest specialized tube mills.

Advanced quality-control procedures — insure dependable UNIFORMITY in all Scovill Mill Products specifications . . . order to order and lot to lot. They promise more accurately dimensioned, finer quality mill products essential to efficient high speed fabrication. Quality-control is a full-time job at Scovill, and the results are evident to fabricators in their own higher production speeds, minimum tool and machine adjustments and superior quality of finished products.

Advanced inspection equipment and methods — There are many inspection stations along each of the Scovill production lines for Brass strip and sheet, rod, wire and tube. In addition, samples of alloy billets and bars, as well as of finished mill products, undergo detailed inspection and test procedures in Scovill's Metals Research laboratories. Brass Mill Products that pass these rigid inspections and tests are considered by many to be the finest in the World.

Advanced packaging — Unique Scovill packaging methods protect quality, finish and condition, make it easier for fabricators to warehouse, handle and use Mill Products. Time- and cost-saving innovations such as extra-long-length coils of strip, self-feeding wire "dispenser" drums, special long lengths when required in tube mill products, are available to fabricators who need them.

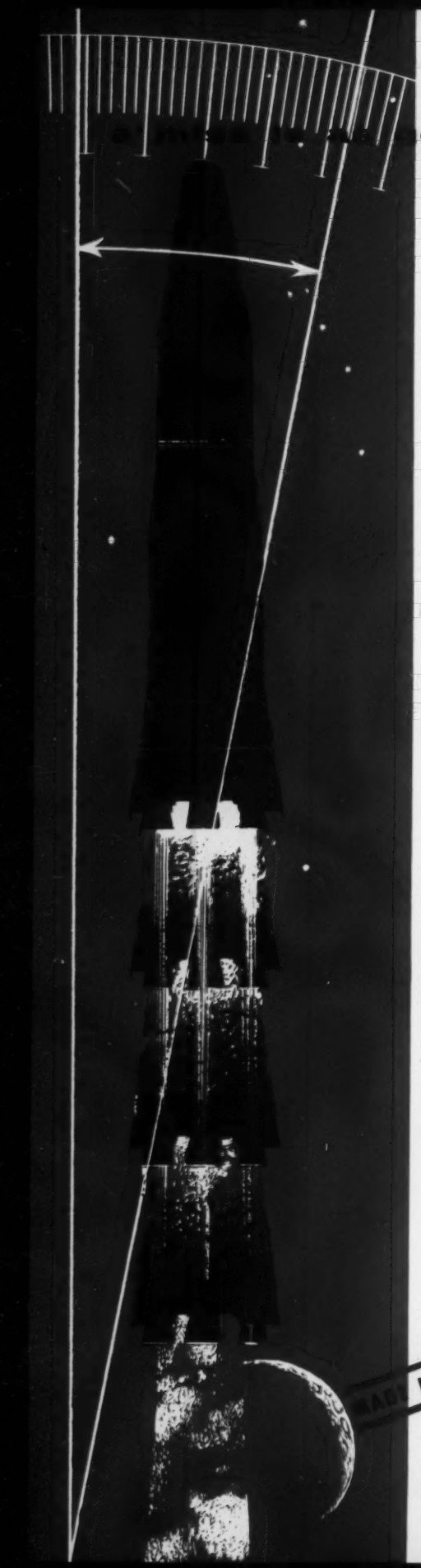
Make Scovill a part of your competitive team, let us contribute our wealth of experience and ultra-modern equipment to the success of your NEW products and production plans.

SCOVILL MANUFACTURING COMPANY
Mill Products Division, 99 Mill Street, Waterbury 20, Conn. Phone PLaza 4-1171

MADE IN USA
. . . and made better to bring out the BEST in your products

7SC60

MILL PRODUCTS



ood as a thousand miles

the higher you aim
for new **productivity**
the more you need
Scovill's "count down"
on quality

SCOVILL®

brass
copper
aluminum

MILL PRODUCTS

MADE IN USA

. . . and made better to bring out the BEST in your products

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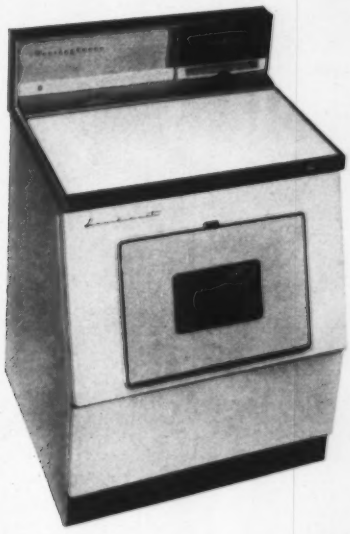
6SC60

On the 1960 Westinghouse Laundromat...



NEOPRENE AND HYPALON® ELIMINATE OZONE-CRACKING: ARE SPECIFIED FOR ALL RESILIENT COMPONENTS

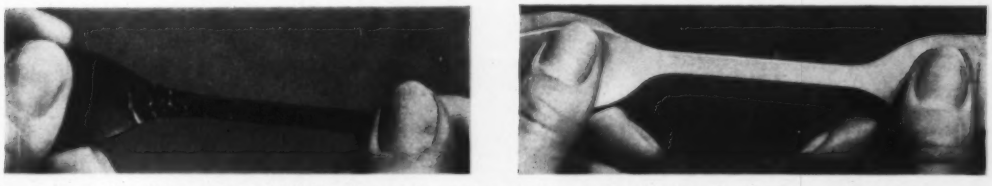
In designing their new Laundromat automatic washer, Westinghouse engineers set out to solve an aggravating problem: ozone deterioration of rubber parts. They knew from experience that drain hose, gaskets, boots and seals made from ordinary rubbers were susceptible to the oxidizing effects of ozone, and they wanted to eliminate this danger in their new design.

Needed were synthetic rubbers capable of performing dependably despite exposure to ozone, heat, abrasion, detergent water and bleach. The solution was provided by a pair of rugged Du Pont elastomers: neoprene and HYPALON.

Neoprene was chosen for its exceptional ability to absorb punishment. Unusually resistant to ozone, this versatile rubber is also highly resistant to heat, abrasion, oils and chemicals. And neoprene's excellent age resistance *keeps* appliances on the job. Neoprene parts stay tough and lively, without cracking, swelling or softening.

HYPALON is *completely* impervious to ozone, whether atmospheric or motor-generated. Ideal for seals, hoses, and other molded or extruded parts, it resists deterioration and stays resilient despite constant abrasion, flexing, temperature extremes.

To learn more about the Du Pont elastomers, and how these synthetic rubbers can solve *your* appliance design problems, write for our fact-filled booklet outlining properties, performance and applications. E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Department MDE-5, Wilmington 98, Delaware.



Ozone tests like this convinced Westinghouse – Specimen on left, made of natural rubber, has deteriorated completely after only 14 minutes of ozone exposure. One on right, made of HYPALON, is unaffected after 100 hours of exposure to the same concentration of ozone.

DU PONT
REG. U. S. PAT. OFF.

SYNTHETIC RUBBER
NEOPRENE HYPALON® VITON® ADIPRENE®

Better Things for Better Living . . . *through Chemistry*

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For more information, turn to Reader Service card, circle No. 494

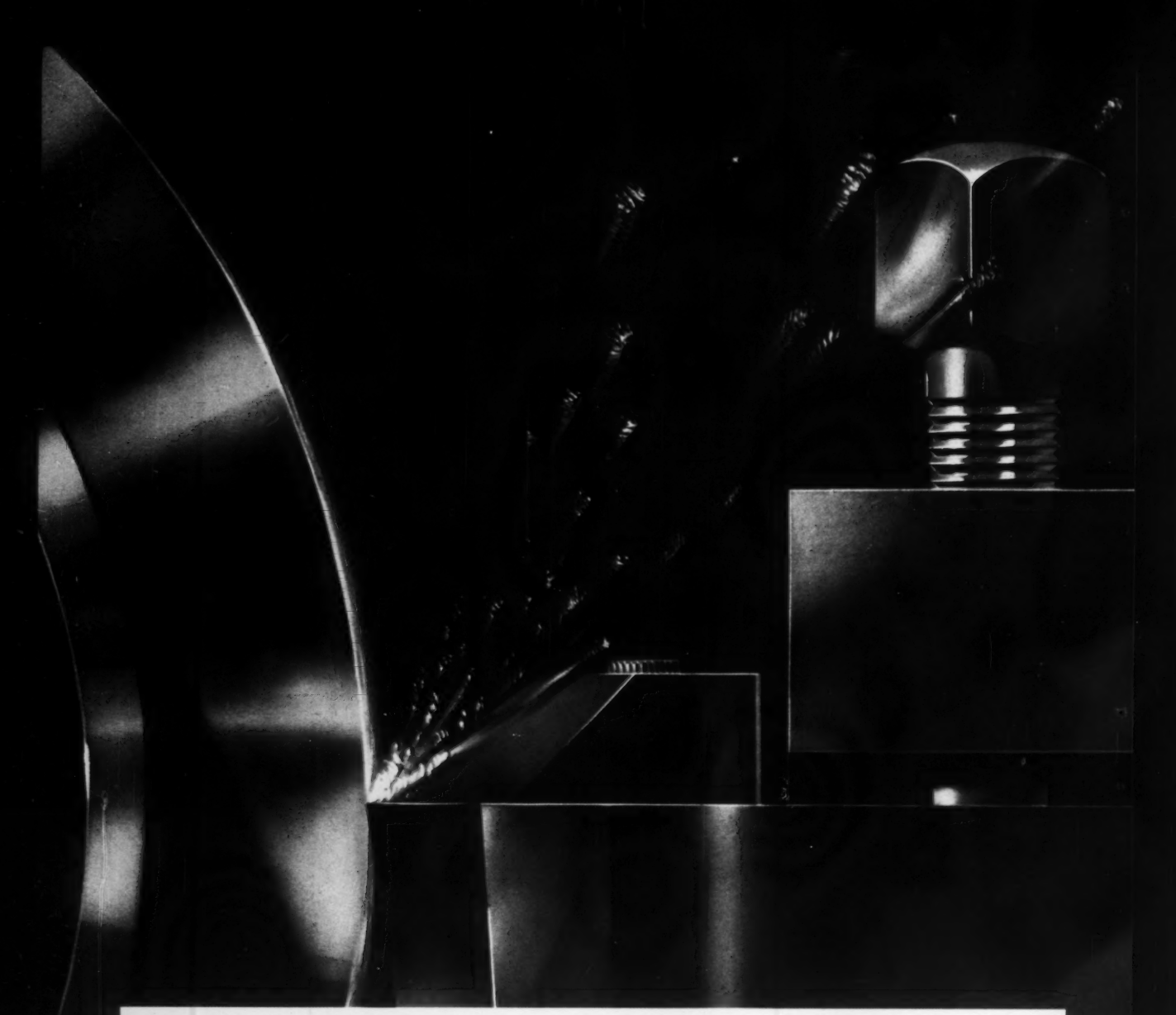


Illustration of Malleable casting being turned at 1,400 surface feet per minute with a 0.100" depth of cut using an oxide tool.

Cut Machining Time and Costs... Use Malleable

It's the **finished** cost of machined components that's important to you. Remember then . . . Malleable iron is the most readily machinable of all ferrous metals of similar properties. With Malleable castings you'll reduce machining time as much as 50% . . . increase tool life up to 250% . . . get unexcelled surface finishes.

Find out how much you can cut **your** finished parts costs. Contact any nearby Malleable castings producer who displays this symbol—

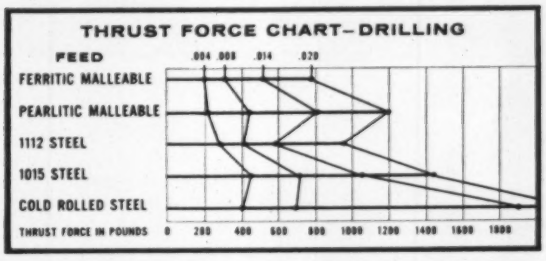
MEMBER
MALLEABLE
CASTINGS COUNCIL

For detailed information on "Machinability of Malleable Castings", contact any of the progressive companies listed on the opposite page, or Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.

You'll Get Faster Machining...Better Finished Surfaces... Longer Tool Life with Malleable Castings

Whatever your machining goals—reduced cycle times, lower tool costs or better surface finishes, you will profit from remembering this fact: Malleable is the most machinable of all ferrous metals of comparable properties.

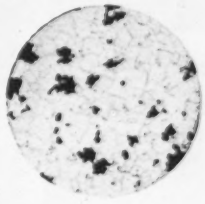
For example, compare the force required to drill Malleable with that required to drill other commonly used metals as we have done here—



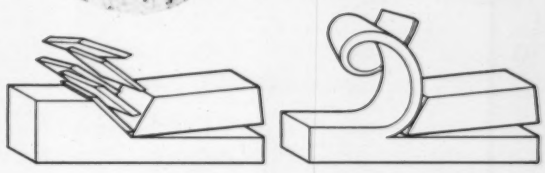
For this test we used ½ inch high speed steel twist drills with a suitable lubricant and a spindle speed of 715 RPM. AISI 1112 steel (Bessemer screw stock) was included because it is often used as a standard for machinability comparisons. Since machining may cost 2 to 4 times as much as the rough parts, the superior machinability of Malleable iron, as demonstrated here, can result in very large savings.

Chips Reveal the Secret of Malleable's Machinability

In addition to providing strength and ductility, Malleable's internal structure of microscopic carbon nodules allows Malleable to break easily into small chips as it is machined. This kind of Type I chip is highly desirable. Speeds and feeds can be increased . . . power consumption drops . . . cutting tools last longer. Malleable's uniform structure permits safe machining at maximum speeds.



Spherical carbon nodules (black) help break up chips. Photomicrograph 50X, etched.



Schematic drawing illustrates how Malleable (left) breaks into short, discontinuous Type I chips, rather than long, continuous Type II and III chips (right).

Future Promises New Triumphs for Malleable

With over two years' experience in advanced machining research, forward-looking Malleable castings producers already know how Malleable will perform when oxide cutting tools come into wide use. In experiments like the one illustrated on the opposite page it has been demonstrated that Malleable can be successfully machined at speeds as high as 1400 surface feet per minute and a 0.100" depth of cut! Surface finish, tool life and metallurgical structure are excellent . . . All this in a metal of rugged engineering properties.

Prove for yourself how much Malleable's machinability will do for your products . . . and your profits. Get in touch with one of the Malleable castings producers listed below. Call today.

Send for Free Machining Information—A special folder, *Data Unit 106, Machining Malleable Iron Castings*, is available from the Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio, or from any member company.

For Quality and Economy...Use MALLEABLE

For Service In Your Area Contact...

CONNECTICUT
Connecticut Mall. Castings Co., New Haven 6
Eastern Malleable Iron Co., Naugatuck
New Haven Malleable Iron Co., New Haven 4

DELAWARE
Eastern Malleable Iron Co., Wilmington 99

ILLINOIS
Central Fdry. Div., Gen. Motors, Danville
Chicago Malleable Castings Co., Chicago 43
Moline Malleable Iron Co., St. Charles
National Mall. and Steel Castings Co., Cicero 50
Peoria Malleable Castings Co., Peoria 1
Wagner Castings Company, Decatur

INDIANA
Albion Malleable Iron Company, Muncie Division, Muncie
Link-Belt Company, Indianapolis 6
National Mall. & Steel Castings Co., Indianapolis 22

IOWA
Iowa Malleable Iron Co., Fairfield

MASSACHUSETTS
Belcher Malleable Iron Co., Easton

MICHIGAN
Albion Malleable Iron Co., Albion
Auto Specialties Mfg. Co., Saint Joseph
Cadillac Malleable Iron Co., Cadillac
Central Fdry. Div., Gen. Motors, Saginaw

MINNESOTA
Northern Malleable Iron Co., St. Paul 6

MISSISSIPPI
Mississippi Malleable Iron Co., Meridian

NEW HAMPSHIRE
Laconia Malleable Iron Co., Laconia

NEW YORK
Acme Steel & Mall. Iron Works, Buffalo 7
Frazer & Jones Company Division Eastern Malleable Iron Co., Solvay
Oriskany Malleable Iron Co., Inc., Oriskany
Westmoreland Mall. Iron Co., Westmoreland

OHIO
American Malleable Castings Co., Marion
Central Fdry. Div., Gen. Motors, Defiance
Dayton Mall. Iron Co., Ironton Div., Ironton
Dayton Mall. Iron Co., Ohio Mall. Div., Columbus 16
Maumee Malleable Castings Co., Toledo 5
National Mall. and Steel Castings Co., Cleveland 6

PENNSYLVANIA
Buck Iron Company, Inc., Philadelphia 22
Erie Malleable Iron Co., Erie
Lancaster Malleable Castings Co., Lancaster
Lehigh Foundries Company, Easton
Meadville Malleable Iron Co., Meadville
Pennsylvania Malleable Iron Corp., Lancaster

TEXAS
Texas Foundries, Inc., Lufkin

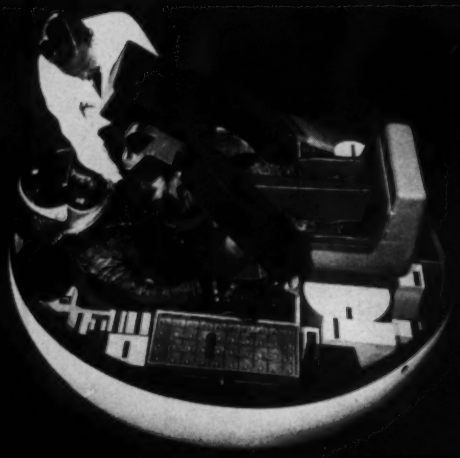
WEST VIRGINIA
West Virginia Mall. Iron Co., Point Pleasant

WISCONSIN
Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company, Inc., West Allis 14
Kirsh Foundry Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
Milwaukee Malleable & Grey Iron Works, Milwaukee 46

Applications

URETHANE FOAMS

Available in flexible, semi-rigid or rigid form, these lightweight, tough and durable materials are adaptable to almost any type of fabricating technique: sliced, stitched, stapled, contour cut or molded in place. *Function:* Cushioning, shock padding, void filling, acoustical and thermal insulation, packaging, molded forms, structural panels, air and fluid filters, fabric lining.



Astronaut Space Couch produced for Astro Systems Research Laboratories, Norair, Division of Northrop Corp., by American Latex Products Corp.

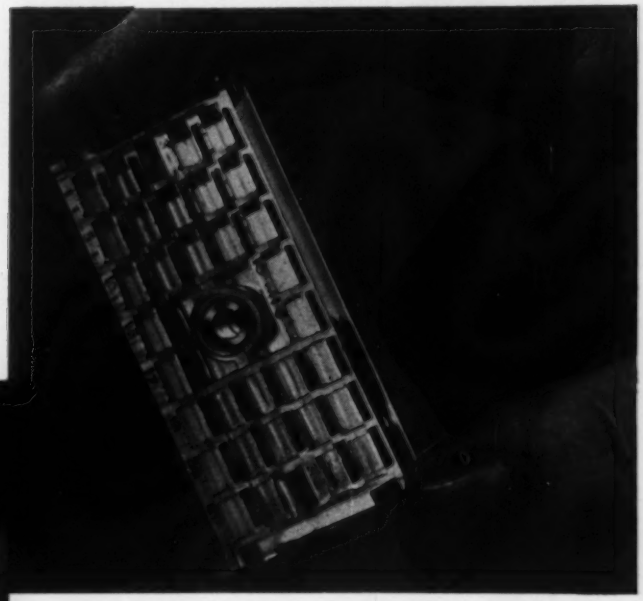
URETHANE COATINGS

A chemically-engineered protective coating that builds a glossy protective armor through chemical cross-linking of its molecular structure. Highly resistant to impact, abrasion, corrosion, chemical attack with a light reflectance rating 15 points higher than clear plate glass! *Function:* Solderable wire coatings, marine finishes, storage tank lining; flexible coatings for rubber, leather, paper, textiles, conveyor belts; hard coatings for ceramics, hardboard, swimming pools, structural uses.

ISOCYANATES developed and manufactured by Mobay are the "building block" chemicals used to create the urethane materials shown. Isocyanates are efficient modifiers of many common compounds, fluids and fibers which, in turn, affect the design potential for standard functional units. *Examples:* May be used to modify self-adhering characteristics of compounds, control solubility or viscosity of fluids and greases, reduce shrinkage of fibers, improve mechanical strength of certain solid polymers, increase wear properties of leather and wet strength of paper. Ad infinitum.

Unlimited...

with materials designed to whet your creative engineering talents



URETHANE ELASTOMERS

One of the very few elastomeric compounds which combines high hardness and density with resilience and elasticity. Exceptional impact strength and resistance to wear and aging, abrasive slurries, solvents, greases and oils. Cast from liquid Multrathane® chemicals in simple molds. *Function:* Long-wearing, silent gears, pump parts, power belts, couplings, shock mounts, solid tires, pullies, diaphragms, sheave lining, encapsulations.

MERLON® POLYCARBONATES

The newest and most versatile of the industrial thermoplastics, Merlon combines excellent dimensional stability, exceptional mechanical strength and good electrical properties over a wide temperature range. May be injection molded, extruded or vacuum formed, or machined from tube or bar stock. Self-extinguishing. *Function:* Computer parts, electrical components, meter cases, housings, grilles, pump impeller parts, bushings, tubing, lenses.

If your field of interest lies in any category of product engineering which requires materials with unusual combinations of unconventional properties, you will find these urethane and polycarbonate materials an interesting and fertile field for exploration. Write Mobay Chemical Company for technical literature, properties and application data based on design and engineering case histories. For prompt assistance, please enclose specifications and use requirements if available.

DESIGN ENGINEERING SHOW
May 23-26

Space 1135
New York Coliseum

p-1

MOBAY
First in Urethane Chemistry

MOBAY CHEMICAL COMPANY
Dept. MD-12, Pittsburgh 5, Pa.
For more information Circle No. 522

Mobay manufactures isocyanates, polycarbonates, and urethane chemicals for foams, elastomers and coatings.

"SHELVED" PROJECTS NOW POSSIBLE

Super Alloys key to advanced development work

Marked improvement in elevated temperature properties of new superstrength alloys is permitting design engineers to move ahead on projects once considered impractical. This is perhaps most evident in the aircraft, missile, jet and turbine power fields. It is, by no means, limited to these alone.

Using advanced techniques and processes, metallurgists are producing a variety of new and improved alloys with superior physical properties.

Where strength at elevated temperatures is the major factor, alloys containing Titanium as the alloying element offer many practical advantages. We suggest that investigation of these titanium-bearing alloys now may lead to the design and production of end products with many new application possibilities. A letter to our N Y C office can be a logical first step to getting certain projects off the shelf and into being.

TAM

DIVISION NATIONAL LEAD COMPANY

Executive Offices: 111 Broadway, New York City

General Offices, Works and Research Laboratories: Niagara Falls, N. Y.

TAM Titanium-additives are used as an alloying element in producing superstrength alloys in the following groups:

CHROMIUM, NICKEL, IRON

CHROMIUM, NICKEL, COBALT, IRON

NICKEL-BASE

COBALT-BASE

For more information, turn to Reader Service card, circle No. 509

THIS IS GLASS

A BULLETIN OF PRACTICAL NEW IDEAS FROM CORNING

THE UNEARTHLY USE OF GLASS

Some day the stellar equivalent of an archeologist will ferret his way through space, collecting debris from the sundry objects we are thrusting out past the pale of gravitation.

That man is going to find a lot of glass.

Next to the metals, glass is *the* basic material for space work. Big claim? Big fact.

You can blast glass out at the stars, shine the sun at it full open, slide it into the cold void of the earth's shadow, plummet it back into the searing atmosphere, recover it from the bobbing waves. And, all the time, glass will hold to its integrity, its properties, its dimensions.

You can design glass *into* a piece of space hardware; you can only know the beauty of this if you have had to design *around* some other material that has interesting properties but is hard to work.

Glass has hardly any design limitations. We can mold it, blow it, fuse it, press and roll it, etch it, temper it, or try any of a dozen other controlled techniques to meet exactly the shape you want, exactly the size you want, exactly the exactness you want.

We have some 60,000 glass formulae to select from, so matching your specs on properties is a snap.

We have combinations of glasses that transmit or attenuate all of the visible light spectrum and most of the infrared and ultraviolet as well.

We can take a mass of glass yards thick and make it as transparent as the objective lens on a microscope, as surface perfect as the facet on a ten-carat diamond.

Big claims? Big facts. Radomes, windows for space capsules, giant mirrors for balloon-floated telescopes, electronic components, macro and micro in size . . . these are just a few of the things you can do with glass . . . and, with all that, you haven't begun to tap the possibilities of glass in space.

We have two brochures that tell about these properties and design potentials: *This Is Glass* treats of the material itself. IZ-1 discusses the applications. Check the coupon for copies.

WE'LL GROW RED ROSES IN JUNE, JUST YOU AND I UP ON THE MOON

It goes without saying that you cannot grow terrestrial plants in a 10^{-12} mm Hg atmosphere . . . but just how high does the pressure have to be to bring a plant to maturation? What about the effects of a lower gravity? What sort and how much light will you need to make a seedling stir? How about temperature?

Republic Aviation is engaged in some research of this sort, which will form a sort of almanac for the lunar farmer.

We come into the picture with a vacuum-tight greenhouse, often referred to as a PYREX brand bell jar. Besides serving as the perfect lunar greenhouse, it recommends itself on a weight basis.

You might remember this "Moon Garden" if the time comes when you want an environment you can play with and observe. Many are the people using our bell jars for high vacuum and high pressure work, for the creation of an inert gas atmosphere; in short, for any work where you want to free yourself from the deficiencies of the terrestrial atmosphere.

HOW TO SEEK OUT AND HIT A MELTING ICE CREAM CONE IN THE MIDDLE OF ALASKA

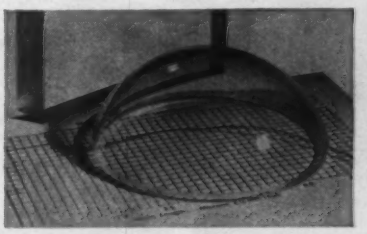
We make the glass that goes into the domes that transmit the infrared waves that activate the cunning minds of the heat-seeking missiles that go pow.

Today we make a better IR transmitting glass than ever before. We call it Code 9752.

A 2mm thickness of this glass will transmit 77% at the 4.0 micron wave length and 38% at 5.5 microns. Not bad.

At 600°C there is no transmission loss whatsoever at 4.0 microns, only 13% at the 5.5 micron wave length.

Our research people say the glass has



"good" electrical properties, "excellent" weathering characteristics. Our research people are known as conservatives.

In a durability test, we found that there was no appreciable transmittance loss in 21 days at 95% RH with temperature cycling from 25°C to 65°C twice a day.

Using standard techniques, we can mass produce this glass in a variety of hollow shapes and give it an optical finish. We can press 7″ domes automatically and make larger sizes to order. Flat pieces, 12″ square and ½″ thick, are being used in the instrumentation field for such devices as Schmidt corrector plates.

The coupon offers a bulletin on this and two other Corning IR transmitting glasses.

See us at the Design Show . . . Booths 1507-1509

CORNING MEANS RESEARCH IN GLASS

CORNING GLASS WORKS, 50 Crystal St., Corning, N. Y.

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- ☐ IZ-1
- ☐ IR transmitting glasses

Name..... Title.....

Company.....

Street.....

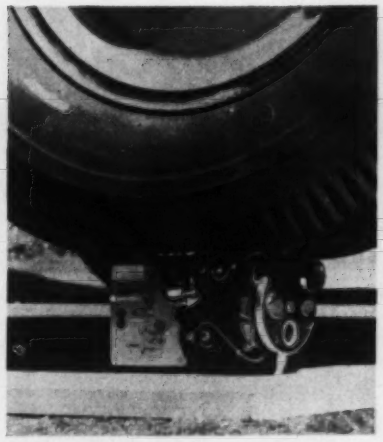
City..... Zone..... State.....

For more information, turn to Reader Service card, circle No. 496

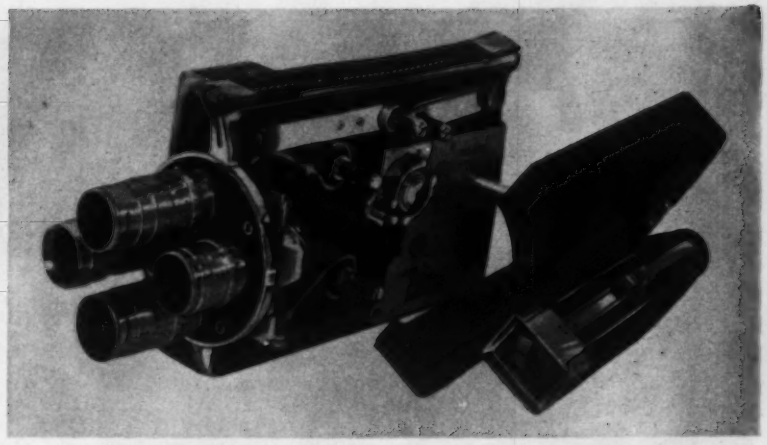
MAGNESIUM DIE CASTINGS MAKE NEW MOVIE CAMERA 31% LIGHTER, EASIER TO HANDLE

Using magnesium alloy in this Wittnauer "Cine-Twin" —that converts from camera to projector in 30 seconds—cut original design weight by almost one-third!

The case of the world's first movie camera-projector—the "Cine-Twin"—is made up of five magnesium precision die castings, produced to very close tolerances in Dow's Bay City, Michigan, die casting plant. By turning to magnesium castings for the case, Wittnauer gained not only substantial weight savings, but strength



Magnesium alloy die castings provide not only lightness for easy handling, but extreme strength and rigidity to withstand even the severe test shown above.



The Wittnauer "Cine-Twin" uses a total of five Dow magnesium precision die castings to form the cover. Total weight of the castings: 0.587 lb.

and rigidity to safeguard the precision mechanism inside.

In designing this new camera-projector, 4 pounds was selected as the ideal weight to aim for—light enough to handle, heavy enough to steady it in use. By substituting magnesium for the metal originally considered, the design weight was reduced by nearly 29 ounces per unit, a weight saving of 31%. As produced, the camera weighs *just 4 pounds.*

NEW DIE CASTING PLANT, ADVANCED METHODS . . .

New plant, advanced methods, latest equipment . . . here's a thumb-nail sketch of Dow's Bay City, Michigan, die casting plant for both aluminum and magnesium, which produces these castings for the Wittnauer division of Longines-Wittnauer. Here you'll find efficient plant layout, highly trained, experienced personnel, and modern quality control equipment that means economy through increased production. A complete range of equipment sizes and types is at hand, too. For example, a Dow developed device automatically meters magnesium to casting machines, substantially boosting production rates. One of the country's largest casting machines is at work here. And backing up this plant is 30 years of Dow experience in production die casting.

MORE DIE CAST PARTS PER POUND . . .

Magnesium gives you multiple production advantages. First, you get more die cast parts per pound of magnesium than from any other metal . . . as much as 50% more parts than aluminum, 4 times as many parts as from zinc. For example, from 6 pounds of magnesium you can die cast 6 parts, whereas from 6 pounds of aluminum you get only 4 parts, and from zinc only a part and a half!

Magnesium gives you another advantage . . . production rates 50% higher than aluminum in some instances. This is due to the lower heat content of magnesium which results in more rapid solidification in the die.

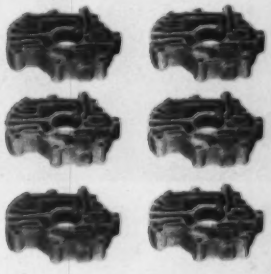
Other production cost factors come down, too. Magnesium machines faster and easier, reducing tool wear while it increases output substantially

* * *

We've prepared a new die casting brochure which shows why our new die casting plant is your best source for light metal die castings. For a copy, contact the nearest Dow sales office, or write THE DOW METAL PRODUCTS COMPANY, Midland, Michigan, Merchandising Department 1052CD5.

FROM 6 POUNDS OF METAL:

magnesium produces 6 die castings



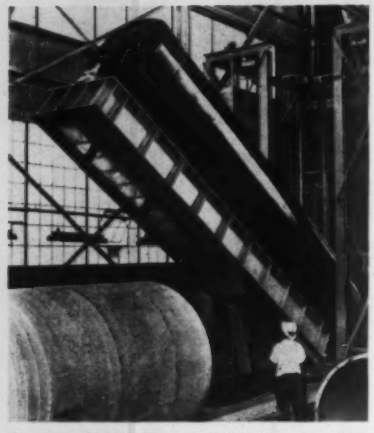
aluminum, 4

zinc, 1½

See "The Dow Hour of Great Mysteries" on NBC-TV

DOW **THE DOW METAL PRODUCTS COMPANY**
Division of The Dow Chemical Company

For more information, turn to Reader Service card, circle No. 323



Electrically-heated shock-proof shipping container designed at Lockheed keeps submarine-launched Polaris FBM at uniform temperature. Two-inch layer of Stafoam provides insulation, helps protect vital controls even on corduroy roads.

AMERICAN LATEX PROD. CORP., 3341 West El Segundo Blvd., Hawthorne, California. BRANCHES: SAN FRANCISCO, 42 Gough St.; SEATTLE, 2231 5th Ave.; DALLAS, 1300 Crampton St.; HOUSTON, 401 Velasco; OMAHA, 1007 Farnam St.

. . . PROTECTS THE POLARIS FBM

Lockheed Missiles and Space Division insures safe shipment of the new Polaris Fleet Ballistic Missile with a double-lined shock-proof container insulated with one of the many Stafoam packaging formulations. Stafoam's controllable hysteresis provides desirable shock absorbence and its superb insulative properties hold temperature uniform during transit and storage.

Currently, there are more than 1300 applications of this versatile urethane foam in the missile world—for packaging, temperature control, fabrication, filtering, instrument mounts, potting, encasing. Recent technical advances enable the weight, strength, density, texture and thermal characteristics of rigid and flexible Stafoam to be controlled at will, providing practical answers to heretofore insoluble problems.

You, too, will find ideal design solutions provided by this new dimension in material technology. For specific consultation contact the Freedlander R & D Laboratories, American Latex Products, Corp., or its branches.

stafoam®

made by AMERICAN LATEX PRODUCTS CORPORATION, Hawthorne, Calif.
and the parent company, DAYCO CORPORATION, Dayton, Ohio

DC DAYCO HEADQUARTERS FOR NEW IDEAS

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We'll make ONE or ONE MILLION for you

Regardless of the nature of the piece or of the quantity, it is usually good business to let us fabricate your laminated plastics part or parts.

We have the material in stock or can make it quickly, including any modifications necessary to improve it for your purpose. You save time. You have no decisions to make on tolerances, dimensional allowances, clearances on tools, or speeds and feeds to use. Spoilage is not your concern.

Since we make our own special tools, dies or jigs, they are our design problems, not yours. It may be possible to save money by molded-laminated or molded-macerated procedures. We'll tell you.

All you have to do is pay the bill. And this is painless because special tools and skills keep it low. Call your Synthane representative — in any principal city—for a quotation or write Synthane Corp., 3 River Road, Oaks, Pa.

You furnish the print—we'll furnish the part

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Sheets • Rods • Tubes • Fabricated Parts
Molded-laminated • Molded-macerated

For more information, turn to Reader Service card, circle No. 367

ANNOUNCING A NEW CORPORATE NAME

for The Garlock Packing Company

Garlock Inc. becomes the new name for The Garlock Packing Company, Palmyra, N. Y., to reflect more accurately its broad diversification of products and markets.

Originally established to manufacture mechanical packings, Garlock now produces over 2,000 different styles of packings, gaskets, seals, molded and extruded rubber and plastic products for every major industry.

The new corporate name, Garlock Inc., more closely identifies this 73-year-old company with the growth and development of its product lines. *Today, industry goes to Garlock for such widely diversified products as:*

- Hydraulic-Pneumatic Packings
- Oil and Grease Seals
- Gasketing and Expansion Joints
- Braided Packings
- Molded and Extruded Rubber Parts
- Plastic Stock Shapes and Fabricated Parts
- Mechanical Seals for Rotating Shafts
- Metal Packings
- Leather Packings
- Electronic Components
- Dry Bearing Materials
- Fluorocarbon Tank Linings
- Missile and Rocket Components

To help you in selecting or applying these products, Garlock offers the services of over 126 thoroughly-trained sales engineers, 175 electronic component manufacturers' representatives, 180 authorized bearing distributors and 69 foreign distributors. Conveniently located warehouses and stocking points assure Garlock customers of prompt delivery.

At Garlock Inc., design and development of new or improved products and materials is an ever-present objective. To this end Garlock maintains extensive research and laboratory-test facilities. In addition, Garlock engineers and chemists are always ready to work with you in seeking solutions to tough application problems.

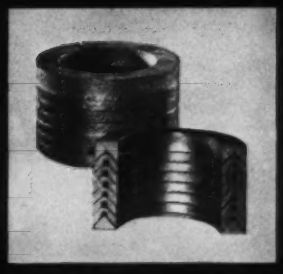
GARLOCK

To find out more about "the new Garlock," call the nearest of our 26 sales offices, or write to Garlock Inc., Palmyra, N. Y. *To assure prompt attention,* please refer to *Garlock Inc.* on all future correspondence and orders.

Canadian Div.: Garlock of Canada Ltd.

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.

For more information, turn to Reader Service card, circle No. 516



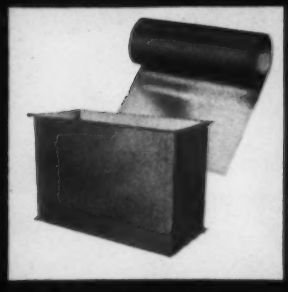
Hydraulic-Pneumatic Packings

Expansion Joints

Molded and Extruded Rubber Parts

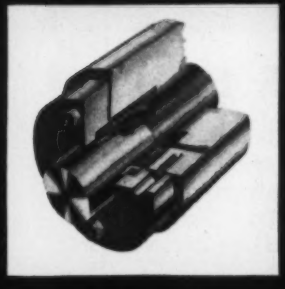
Plastic Stock Shapes
and Fabricated Parts

Braided Packings

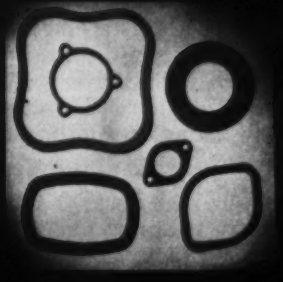


Fluorocarbon Tank Linings

Oil and Grease Seals



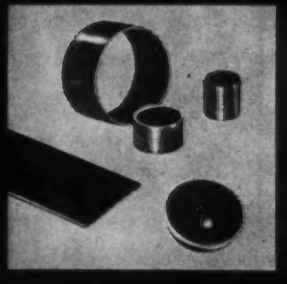
Mechanical Shaft Seals



Gasketing

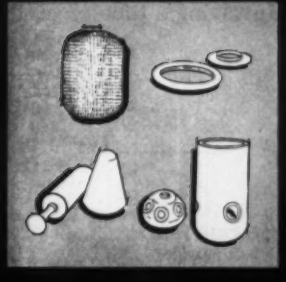
Spiral Wound Gaskets

Metal Packings

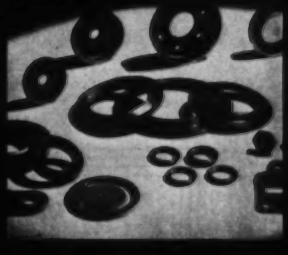


Dry Bearing Material

INC.

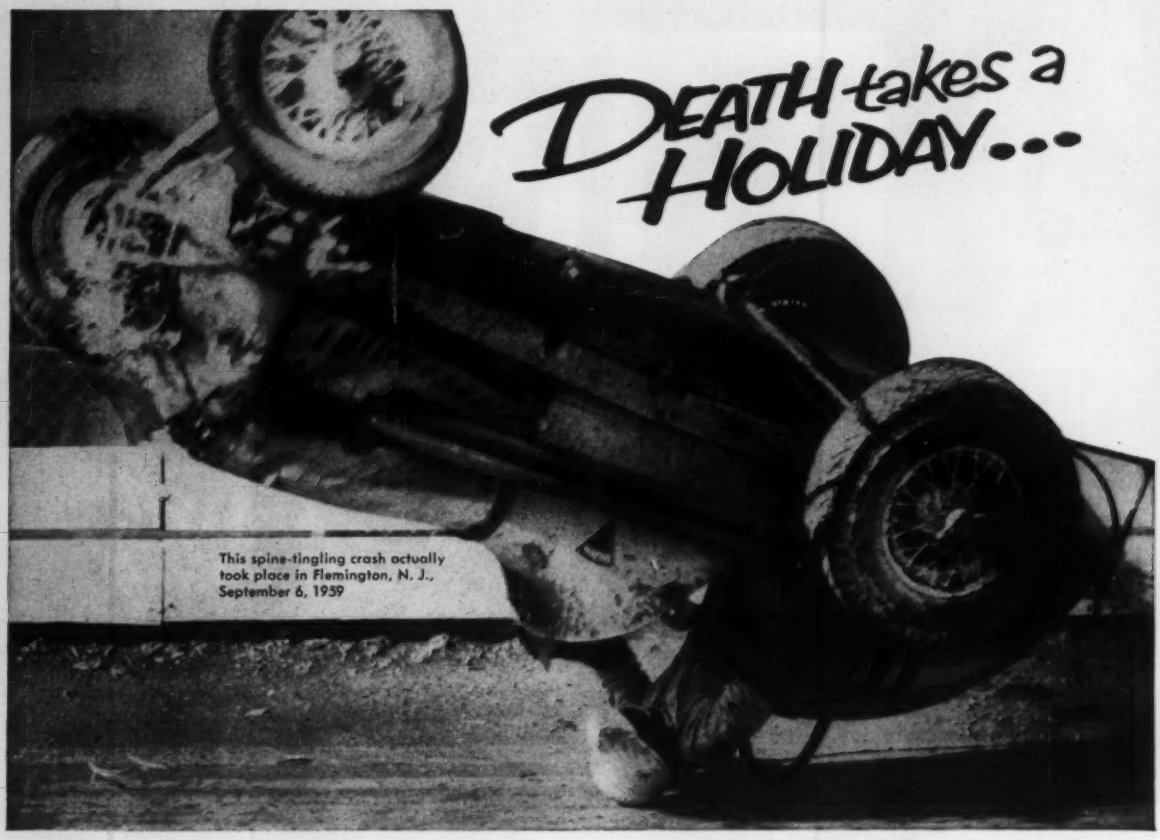


Missile and Rocket Components



Leather Packings

Electronic Components



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- Welded Mechanical Tubing
- Pressure & Hydraulic Tubes
- Centrifugally Spun Tubing
- Stainless Seamless Tubing
- Stainless Welded Tubing
- Stainless Pipe, Valves & Fittings
- Aluminum Tubing, Pipe & Fittings

Call FRASSE 1st for tubing

Spectators gasped when this sprint car skidded—at 95 m.p.h.—into a series of flips that seemed certain to demolish both car and driver. Yet—miraculously, the driver walked away from the wreck with only minor bruises. His roll bar—made from Frasse tubing—had shielded him by taking the full impact of the car...not once, but *four times.*

The capacity to take such abuse is inherent in seamless tubing. It combines the ability to absorb and localize shock, with the ultimate in strength and rigidity in proportion to size and weight. Then too, it possesses superior welding and machining properties. That's why more and more engineers specify seamless tubing... for structural and mechanical applications.

Every tube in Frasse stocks meets the rigid quality specifications set by Frasse tubing specialists. So, if you use tubing in your product —and want trouble-free quality in a hurry...*it will pay to make Frasse your source for tubing.* There's a size on hand to meet every need...delivery is immediate...and Frasse engineers are available to assist you with any problem involving a tubular product.

Peter A. Frasse & Co., Inc.

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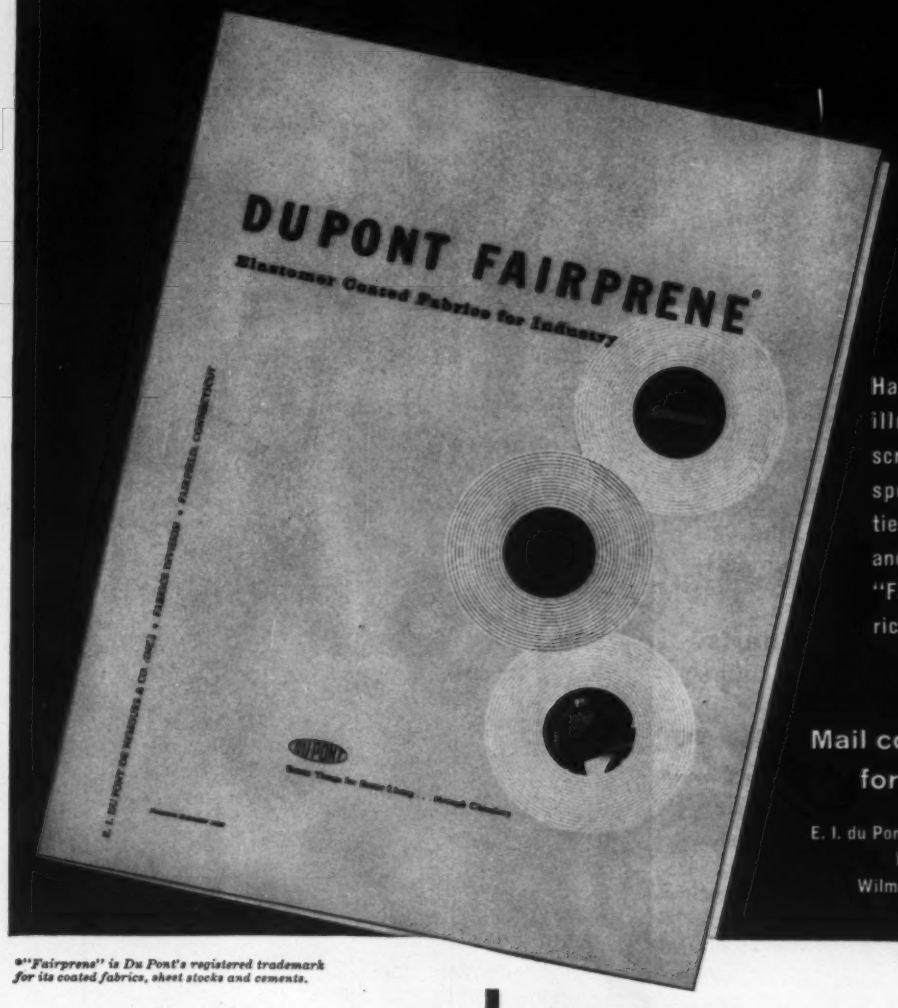
FREE COATED FABRICS MANUAL



Handy, 12-page, fully illustrated booklet describes in detail all basic specifications, properties, uses and performance characteristics for "Fairprene"* coated fabrics and cements.

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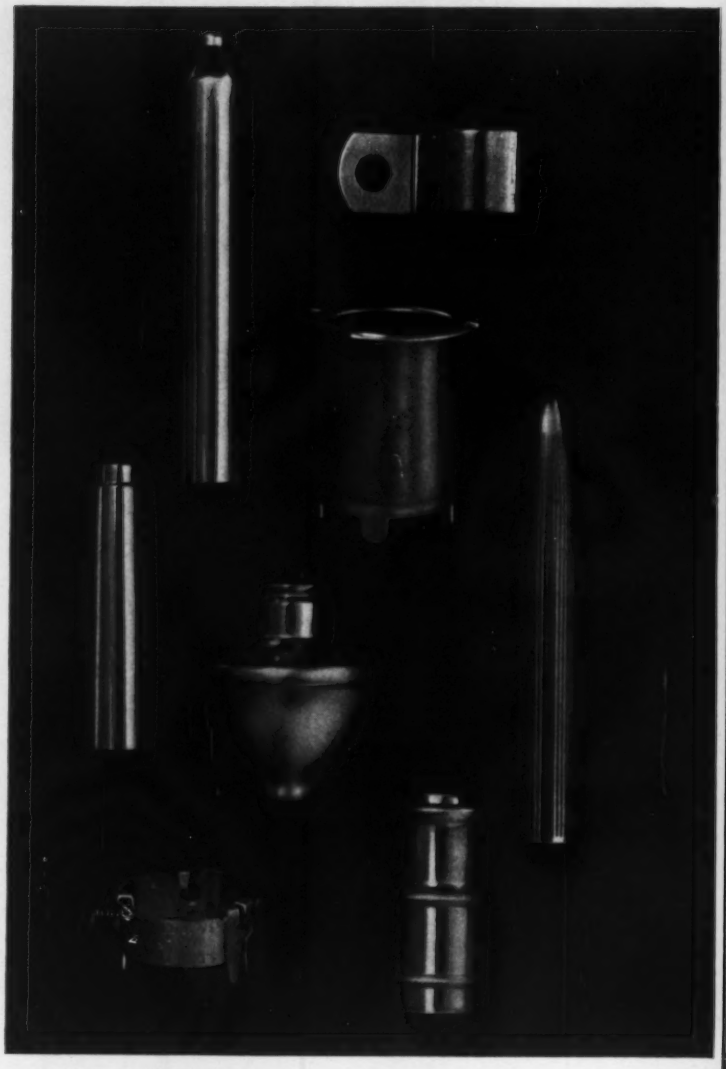
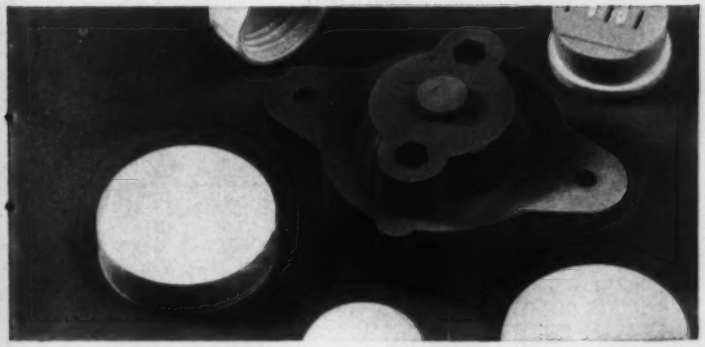
Offers design assistance that can often improve the quality of your part, and lower production costs.

Provides superior quality parts. Sylvania utilizes the most modern equipment available, and its experience in tooling means better quality at lower costs for finished parts. In addition, Sylvania preventive maintenance for dies and equipment assures you precise uniformity, uninterrupted production.



FORMED FROM METAL

Sylvania can supply the parts you need—in the desired high production quantities—to the most exacting specifications—at lower costs. If your part is a deep-drawn eyelet, shell, cup or ferrule—Sylvania has already gained long experience in this field producing millions of fountain pen caps, curtain rod ends, etc. And if it can best be produced by four-slide equipment, Sylvania has produced millions of contacts, retainer clips, electrodes, etc. What's more, vertical press equipment and special Sylvania-developed machines also can produce great quantities of small and medium-size parts to meet your needs daily.

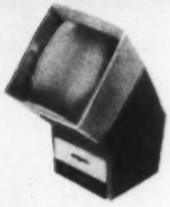


MOLDED FROM PLASTICS

Sylvania maintains one of the world's most complete lines of modern automatic molding equipment for compression, injection and transfer molding. Example: a bank of rotary presses ideally suited to phenolics and urea. These presses can produce millions of parts each day and assure you efficient, quick and low-cost plastic parts in volume.

CUSTOM WELDED

Whether your part is standard-sized, miniature or subminiature, welded assembly is a Sylvania specialty. To help meet your custom welding needs, Sylvania has developed new high-speed, high-volume welding techniques, advanced welding equipment (automatic and semiautomatic) and a corps of trained custom-welding specialists. Result: Sylvania welds assure better electrical and mechanical contact, mirror-image uniformity, low cost.



CUSTOM ASSEMBLED

Many of our customers have analyzed their parts assembly requirements. And they have found Sylvania can often deliver a completely assembled and packaged product—using either all Sylvania components, all customer components or both—at lower cost than is possible within the customer's own facilities.
Result: If your product is small, the parts predominantly plastic and metal, and the quantities 50,000 or more, it pays you to have Sylvania trained specialists assemble it.

*QC MEANS QUALITY CONTROL!

Sylvania maintains a complete quality control department to assure that parts are made to your exact specifications for each component. This control works for you throughout the manufacturing cycle. It's just one more way you benefit when you put Sylvania on the job for parts.
For full details or a quote, write Sylvania Electric Products Inc., Parts Division, Warren, Pennsylvania.

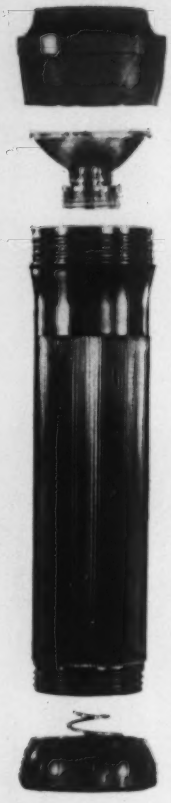
SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**

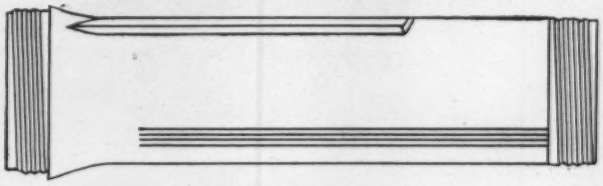
For more information, turn to Reader Service card, circle No. 479

All-plastic case shows finely-drawn functional detail

Tube, lens ring, and cap are all molded of BAKELITE Brand high-density polyethylene. The designer made good use of this material's functional properties. Fine details are reproduced with extreme fidelity—serrations on the tube are precisely formed and provide a firm grip. Minimum finishing after molding helps keep mass production costs low. Tough and rigid with excellent chemical resistance, the flashlight will take hard industrial usage. Its gloss adds sales appeal. On top of all these design advantages, the low price of this material makes it an even stronger value.



Molded-in threads, hidden parting lines make this design unusual



NOTE: EXTERIOR SURFACE OF TUBE TO BE FREE OF ALL PARTING LINES

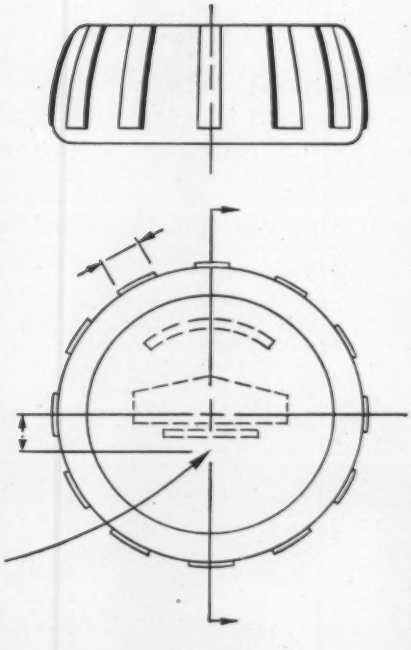
Because of the high temperature resistance of BAKELITE Brand high-density polyethylene, these flashlight components always hold their shape. The molded threads don't soften, keeping the lens ring and cap firmly in place. These are ten-pitch threads, easy to work, hard to strip.

While the threaded sections at the bottom and top of the tube required a parting line, the designer specified that the main body of the tube have no parting line. The one-piece mold used for this feature costs more, but the appearance of the finished product makes it worthwhile. A slight taper in the tube permits easy removal from the mold. Since holes for the switch plate are molded in, there's no need for subsequent operations such as drilling or piercing.

HIGH-DENSITY POLYETHYLENE ...

Clean mold gating, color, feature high-density polyethylene

The designer called for a conventional gate on the flashlight cap mold; the tube and lens ring molds have a "diaphragm" gate used in fabricating tubular plastic designs. See how the finished part compares with his design. The cap and lens ring come in three glossy colors—red, yellow, and green—an attractive combination with the black tube.



This was an informal test—

. . . but it demonstrated the toughness and impact resistance of the BAKELITE Brand high-density polyethylene used in the EVEREADY "Shop Lite." It came through the bump, bounce, and batter undamaged.

IDEA-MATERIAL for NEW DESIGNS

The EVEREADY "Shop Lite" gained several advantages when the designer chose this new polyethylene. Check the high points on these pages...

A new material often expands the designer's opportunities to try new ideas. This is especially true of high-density polyethylene, which offers properties that can reduce costs, extend performance, and improve appearance. Polyethylenes are only one group of BAKELITE Brand plastics—the others are epoxies, phenolics, styrenes, and vinyls—that you can draw on. Molded, laminated, extruded, or in coatings, BAKELITE Brand plastics can be a source of genuine product improvement.

Check their properties in Sweet's Product Design File, section $\frac{2a}{ui}$

Visit our booth at the Design Engineering Show, New York Coliseum, May 23-26.

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Please send me information on the use of BAKELITE Brand Plastics in design with particular emphasis on these properties_____

The type of application being considered is_____

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For more information, turn to Reader Service card, circle No. 531

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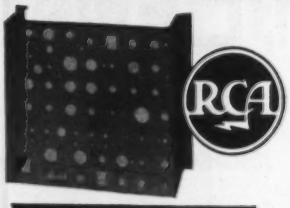

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For more information, turn to Reader Service card, circle No. 451

ENGINEERING & DESIGN

...AT A GLANCE

Lower cost nuclear power plants may result from present research on the corrosion resistance of carbon and low alloy steels. Preliminary studies show that corrosion rates of carbon and low alloy steels remain remarkably low after exposure to a boiling water reactor environment. Reason: a protective oxide film forms on the steel and inhibits corrosion. The film is produced by the action of oxygen and hydrogen in the boiling water.

Source: W. L. Pearl, General Electric Atomic Power Equipment Dept., San Jose, Calif.

Impact sensitivity of materials in contact with liquid oxygen can be determined accurately and safely by using a new test apparatus. A free-falling plummet lands on a striker pin that is in contact with a specimen under test. The bottom of the striker pin and the specimen are immersed in liquid oxygen. Energy is transferred from the falling plummet to the specimen with a minimum of splashing of the liquid oxygen.

Source: W. A. Riehl, Army Ballistic Missile Agency, Redstone Arsenal, Ala.

Interest is boron as a structural material continues. Reason: it has low density (0.08-0.09 lb per cu in.), high melting point (3600-4000 F), high room temperature hardness (2800 VHN), high elastic modulus ($>50 \times 10^6$ psi), and relatively high specific heat (0.263 Btu/lb/°F at 68 F). However, the purest material available today shatters at low impact, has no ductility, and has such poor thermal shock resistance that it breaks up on slow cooling.

Source: Literature survey by D. N. Williams, Battelle Memorial Inst., 505 King Ave., Columbus 1, Ohio.

Strength of glass-reinforced plastics laminates is decreased if glass fabrics are exposed to humidities over 65% before laminating, recent research indicates. Humidities below 65% have no effect on the strength of laminates.

Source: B. G. Heebink, Forest Products Laboratory, Madison, Wis.

New information on dislocation motion in metals has been obtained by measuring sound waves moving through an irradiated bar of high purity copper. The measurements gave accurate information on how much energy was absorbed by dislocations and how much these imperfections slow down sound waves. The measurements also provided information on the effect of sound waves on the motion of dislocations.

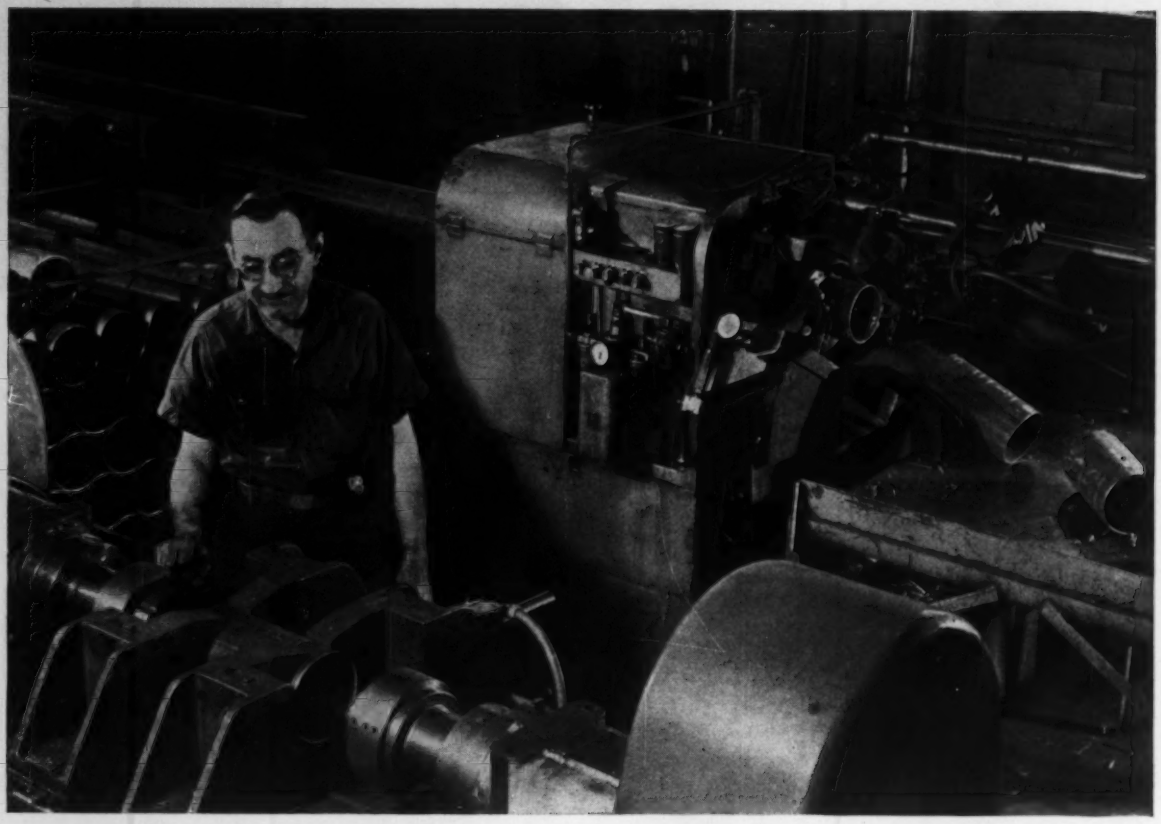
Source: G. Alers, Scientific Laboratory, Ford Motor Co., Dearborn, Mich.

Chromized mufflers might last the life of a car, a recent proprietary study indicates. Examination of a chromized muffler showed no corrosion or weakened steel inside or outside after 30,000 miles of continuous use for more than four years, even when pounded with a hammer.

Source: Chromalloy Corp., 452 Tarrytown Rd., White Plains, N. Y.

A new value for the atomic weight of silver is 107.873 $\pm$0.0016 on the chemical scale and 107.9028 $\pm$0.0011 on the physical scale. The value was obtained by accurately measuring silver's isotopic abundance ratio.

Source: Rpt. No. 2458, U. S. Dept. of Commerce, National Bureau of Standards, Washington 25, D. C.



Tubing for this job must meet the most rigid specs

This manufacturer of heavy-duty idler rollers has turned to increased automation and tighter material specs to improve production. Note automatic feed and cutoff of tubing in background . . . the quick setup for double-end counterboring at the next station.

Tubing for this job must meet highest standards for uniformity of size, straightness and close tolerance of concentricity. But where do you find large O.D. tubing to meet these rigid specs? At Ryerson, of course—home of the industry's tightest quality controls.

Here you choose from the nation's largest stocks. And you're assured of consistent quality that is so important to meet the demands of automation. The more automated your production line, the less chance for visual inspection, and the more dependent you are on the consistent quality of the raw material.

So when you next need tubing or help with selection and application problems, be "Metalogical"—call Ryerson.

The type of tubing you need is here

Carbon Steel Tubing—seamless and welded, round and square, cold drawn and hot finished.
Alloy Steel Tubing—seamless rounds.
Fluid Power Tubing—Rockrite cylinder finish, seamless and welded; hydraulic fluid line; seamless and welded cylinder tubing.
Structural Tubing—square, rectangular and round.
Ledloy® 170 Tubing—fast machining, 170 sfm.
Stainless Pipe and Tubing—cold drawn seamless and welded. Also welded ornamental.
Aluminum Pipe and Tubing—all commonly used alloys and tempers.
PVC Pipe and Tubing—time-tested Ryertex®-Omicron PVC.

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For more information, turn to Reader Service card, circle No. 528

Hot Melts	*Low cost, easy to use*
Styrene-Polyesters	*Good electrical and mechanical properties; easy to handle*
Epoxies	*Low shrinkage, good adhesion*
Modified Epoxies	*Wide range of hardness and flexibility*
Silicones	*Stable at high temperatures*
Liquid Elastomers	*Cushion shock and vibration*
Foams	*Lightweight; cushion shock and vibration*

A guide to

Potting and Encapsulation Materials

Part 1 — ***Selection factors*** / ***Seven types and their properties***

by C. V. Lundberg, *Bell Telephone Laboratories*

■ The protection of electrical components and networks by potbedding) has shown remarkable growth in the past few years. The importance of these casting methods stems from their ability to ting and encapsulation (or emisolate electrical components from moisture, corrosives, dirt, dust and other environments, and from their ability to increase the resistance of components to shock and vibration.

This article describes the factors you should consider when selecting a potting or encapsulating material, and describes the materials that are available. Typical applications and case histories will be presented next month.

Selection factors

Before selecting a potting or embedding material it is essential that the designer define his service requirements. Here are the factors you should consider:

1. To what degree must electrical properties be maintained in adverse environments?
2. Must the component be strengthened mechanically and protected from shock and vibration? Will a rigid or resilient potting or encapsulating material be required?
3. What is the required overall size and weight of the product after casting and hardening? What percentage of the finished volume will the electrical components occupy?
4. Will mounting holes or screws have to be cast in the compound?
5. What electrical properties (dielectric constant, dielectric strength, dissipation factor, surface resistivity, etc.) are needed?
6. What is the maximum temperature that the components can withstand during casting? What are the minimum and maximum ambient temperatures expected in service? How much heat will be generated by the components and what temperature rise over ambient temperature is estimated?
7. What adverse operating conditions are expected? High humidity and water immersion? Direct outdoor exposure? Corrosive atmospheres? Any other?
8. Will the components be sensitive to shrinkage stresses created when the casting resin hardens?
9. Is cost important?

Once these requirements have been set the designer can then decide which materials to use. The large table on p 126 is intended to serve as an initial selection guide. Keep in mind that it is intended only to narrow down the choice of available materials. For example, let's assume that after consulting the table an epoxy compound appears to be most suitable. Since many epoxy compounds are available, the next step is to consult the specific literature of liquid epoxy resin producers and the companies that formulate

epoxy casting compounds. The importance of consulting specialists in liquid casting resins cannot be overstressed, as the processing properties and idiosyncrasies of materials often do not show up in tables of properties.

Waxes and asphalts

Waxes, asphalts and similar hot melt materials can often supply satisfactory moisture and chemical resistance and physical protection for electrical components. They have excellent electrical properties, and some of them are cheaper than any other potting materials. They are also easy to use since they liquefy when heated. And they do not create any pot-life problems; if not all the material is used at one time, the remainder can be remelted many times without seriously affecting its properties. However, very long heating periods at processing temperatures can produce chemical changes and degradation.

Hot melt materials can soften if the components operate at high ambient temperatures or if excessive heat is produced during operation. In addition, waxes and asphalts tend to shrink from their containers and crack when exposed to temperatures in the 0 to —25 F range. Furthermore, most of the hot melt materials have little structural strength and are not self-supporting.

Styrene-polyesters

Applications of styrene-polyesters are steadily growing because the materials have good electrical and mechanical properties and are relatively easy to handle.

How they form—Casting-type styrene-polyesters consist of unsaturated polyesters dissolved in monomeric styrene. The hardened product may be rock-hard or elastomeric depending on the particular acids and alcohols used in manufacturing the polyester. Adding a peroxide initiator makes the styrene crosslink with adjacent polyester molecules at the points of unsaturation, producing a three-dimensional network.

Some initiators of the hardening or curing reaction work at room temperature; since they produce crosslinking immediately, they provide materials with short pot life. Other initiators require elevated temperatures for curing and thus provide long room temperature pot life.

The reaction between the styrene and polyester is exothermic, i.e., generates heat. Exothermic heat can be considerable and may cause voids and cracks. For any given polyester and initiator system the amount of heat generated depends on the mass of the casting; the greater the mass, the higher the exotherm.

Fillers improve properties—One way to lessen generated heat is to add inert mineral fillers (such as silica, clay, whiting, aluminum oxide, talc, mica and glass fiber). Since the filler occupies space, the volume of resin is smaller and the amount of heat generated is reduced. An added advantage of the fillers is that they increase heat conductivity and minimize local hot spots during gelling and curing. Thus, virtually all casting-type styrene-polyesters used today contain fillers. Clear polymers are used mainly for display purposes.

Fillers also reduce the cost of styrene-polyesters, and can be used to change physical and mechanical properties. Silica-filled styrene-polyester is generally hard, rigid and quite tough. It is strong enough so that mounting studs can often be cast directly in the compound.

Unfilled, hardened resins have relatively high coefficients of thermal expansion; the expansion of filled resins, however, approaches that of common metals. Furthermore, unfilled styrene-polyesters generally shrink 8 to 10% (by volume) after hardening, whereas fillers can reduce shrinkage to 5 to 8%. Nonetheless, the 5 to 8% shrinkage is relatively high.

Suited for encapsulation—Because of their tendency to shrink from potting containers, styrene-polyesters are very often used for encapsulation rather than potting. Cast parts that shrink sufficiently can often be made more economically in removable molds than in potting containers. However, if the potting method is used with styrene-polyesters, the potting container should contain styrene or a plastics material to which styrene-polyesters adhere. Also, the container should be thin-walled and easily deformable so

Potting
Embedding
Encapsulation

What They Mean

Potting, embedding and encapsulation are all liquid casting processes.

Potting consists of placing electrical components or networks in a metal or plastics container which is then filled with an appropriate casting liquid. The liquid subsequently hardens by cooling or chemical action, the container becoming an integral part of the finished item.

Embedding is similar to potting except that the components and liquid casting compound are placed in a temporary container or mold which is removed after the casting liquid has hardened. The finished product is often referred to as an embedment, an *encapsulation*, or as being encapsulated.

Electrical components may also be encapsulated by dipping and spraying. In such cases the liquid encapsulating compound is often thickened with a very fine silica or clay to make it cling to the component and prevent it from draining off. Such thickened mixtures are commonly called thixotropic compounds.

that it can follow the styrene-polyester as it shrinks.

Once a styrene-polyester has cured, little if any change occurs at ordinary temperatures provided parts are not exposed to weathering. Some roughening and dulling of the surface may occur outdoors due to ultraviolet radiation. This surface erosion occurs slowly and can be allowed for by increasing the thickness of the compound.

Epoxies

Epoxies are also showing rapid growth in encapsulating electrical equipment. Many of the commercial epoxies are made by reacting epichlorhydrin with bisphenol A, and curing is accomplished with agents containing active hydrogen, such as amino, carboxyl and hydroxyl groups. As with styrene-polyesters, the epoxy reactions are generally exothermic and fillers are often used to hold down exotherm heat. Unfilled, transparent compounds are occasionally used when it is advantageous to see into the embedment.

As shown in the table, many properties of cast epoxies are similar to those of cast styrene-polyesters. The styrene-polyesters have a price advantage; they cost about half as much as epoxies. However, the epoxies shrink less and thus have less tendency to exert pressure on components and change their electrical characteristics. The epoxies also show better adhesion to most substrates than styrene-polyesters. Good adhesion is particularly important around leads and terminals to prevent the entrance of moisture and other contaminants.

Because of the low shrinkage and good adhesion of epoxy compounds, it can be quite difficult to remove parts from embedding molds. Thus, the materials are often more economically suited for potting. The degree of adhesion produced between the casting and container depends on the particular epoxy compound used, as well as on the size and shape of the casting. A variety of plastics potting containers can be used, and metal containers are sometimes desirable for electrical shielding. As with styrene-polyesters, containers should be thin enough so that they can follow the epoxy compound as it shrinks.

Many epoxy compounds cure satisfactorily at room temperature. However, best properties are developed by heat curing. For many compounds, 1 to 2 hr at 175 to 200 F is adequate, but some compounds require many hours of cure at 300 F or higher in order to develop high heat distortion temperatures. (Heat distortion temperatures should be specified for self-supporting cast parts that must maintain dimensional stability when exposed to high temperatures for long periods.)

Modified epoxies

Because of their high crosslinking the epoxies described above are generally hard and rigid. Less crosslinking and greater resiliency can be obtained by reacting epoxies with polysulfides and polyamides.

Depending on the composition ratio used, epoxy-polysulfide casting compounds can be made in a wide range of hardnesses; e.g., hard and slightly resilient, semi-hard, soft and rubbery. Tertiary amines are generally used as catalysts and the compounds are cured at room temperature. Exothermic heat is produced during curing.

Certain low-molecular-weight polyamide and amide-amine mixtures also react with epoxies at room temperature. As with most other resin mixtures, some properties are improved by heat treatment after hardening. Several hours are usually required for gelling at room temperature, the exact time for a given composition depending on the mass of the mixture. Exotherms are moderate and are lower than those produced by very active amines.

In addition to the polysulfides and polyamides, some additives (or flexibilizers) for the standard epoxies are available which in themselves contain epoxy groups. These additives can react with the standard epoxy casting resins and the usual hardeners to form crosslinked, somewhat flexible potting compounds.

Epoxies can also be reacted with urethanes. These potting and embedding compounds can be varied from rigid to resilient, depending on the properties and quality of the urethane used, as well as the hardener used.

Silicones

Silicone liquid resins that cure to a rigid state are mainly used for impregnating and coating. They usually require long, high temperature cures and have fairly high shrinkage. However, shrinkage can be reduced by using fillers, the filled compounds being suitable for relatively small castings. Unfilled compounds tend to be brittle and are relatively expensive. Both the filled and unfilled compounds have favorable stability at high temperatures.

Liquid elastomers

Silicones—All of the rigid casting compounds shrink as they cure and tend to compress embedded parts. As previously mentioned, pressure sensitive components may have their electrical properties changed by compression. Vulnerable components can be cushioned with a base coating of silicone rubber which cures at room temperature (see photo). The coating can be applied by dipping, brushing or spraying and cures overnight or in one or more hours at moderate temperatures. It is inert to casting resins and does not form an adhesive bond with them.

Since rubbers are essentially incompressible, i.e., if squeezed in one direction they expand in another direction, the cushioning effect of silicone rubber is probably due to the compressibility of air trapped in the rubber. Also, any compressive forces tend to be distributed over the entire surface of the component because of the rubber's flexibility and its lack of adhesion to the casting resin.

Liquid silicone rubber can also be used as the sole encapsulant for components and networks. It has good electrical properties, sta-

Material → / ASTM ↓		Hot Melts				Rigids (silica-filled)		
		Micro-crystalline Wax	Oxidized Asphalt	Silica-Filled Asphalt	Gel-Type Compound	Styrene-Polyester	Epoxy	Silicone
ELECTRICAL PROPERTIES								
Dielec Str, v/mil[a]	D149	500	500	500	500	425	425	350
Dielec Const								
60 Cps	D150	2.5	2.7	3.9	2.3	3.7	3.8	3.7
10^3 Cps	D150	2.5	2.7	3.9	2.3	3.7	3.6	3.6
10^6 Cps	D150	2.4	2.6	3.6	2.3	3.6	3.4	3.6
Dissip Factor								
60 Cps	D150	0.005	0.014	0.02	0.0005	0.01	0.02	0.008
10^3 Cps	D150	0.008	0.012	0.02	0.0005	0.02	0.02	0.004
10^6 Cps	D150	0.001	0.006	0.01	0.001	0.02	0.03	0.01
Surface Res, ohms/square								
Dry	D257	$>10^{16}$	$>10^{16}$	$>10^{16}$	$>10^{16}$	10^{15}	10^{15}	10^{15}
After 96 Hr at 95 F, 90% RH	D257	$>10^{16}$	$>10^{16}$	$>10^{16}$	$>10^{16}$	10^{11}	10^{13}	10^{15}
Vol Res (dry), ohm-cm	D257	$>10^{16}$	$>10^{16}$	$>10^{16}$	$>10^{16}$	$>10^{15}$	$>10^{15}$	10^{15}
MECHANICAL PROPERTIES								
Ten Str, psi	D638, D412	—	—	—	—	10,000	9,000	4,000
Elongation, %	D412	—	—	—	—	—	—	—
Compr Str, psi	D695, D575	—	—	—	—	25,000	16,000	13,000
Flex Mod of Rupture, psi	D790	—	—	—	—	10,000	12,000	8,000
Izod Impact Str (notched), ft-lb	D256	—	—	—	—	0.3	0.4	0.3
Shore Hardness	D676, D1484	—	—	—	—	—	—	—
Penetration at 77 F, mils	D5	12	30	16	>200	—	—	—
Shrinkage on Cooling or Curing, % by vol		16	9	6	9	6	3.5	8
PHYSICAL PROPERTIES								
Specific Gravity	D71, D792	1	1	1.5	0.94	1.6	1.6	1.8
Min Cold Flow, F		170	140	220	185	—	—	—
Softening or Drip Pt, F	D36	185	200	300	200	—	—	—
Heat Dist Temp, F	D648	—	—	—	—	230[b]	165[b]	300
Max Cont Service Temp, F		170	140	220	185	250	250	480
Coef of Ther Exp, per °F, x 10^{-6}	D696	—	—	—	—	26	22	44
Ther Cond, Btu/sq ft/hr/°F/ft		Fair	Good	Good	Fair	0.193	0.29	0.23
COST ($/lb)		0.10-0.30	0.05	0.10	0.40	0.25	0.50	2.75

[a]Values are for specific compounds; in most cases values can be altered by changing composition.
[b]Some compounds have heat distortion temperatures of 300 F and higher.
[c]6 lb per cu ft. [d]10 lb per cu ft.
[e]Short time test on ⅛-in. specimen.

ble mechanical properties during aging, and withstands cycling tests and service conditions over a wide temperature range.

Polysulfides—In addition to being combined with epoxies, liquid polysulfides can also be used alone. The elastomeric and adhesive properties of polysulfide compounds are useful in many potting and sealing applications, especially where weatherability and flexibility are needed over a wide temperature range.

Initial gelling of polysulfides occurs in a few minutes or in several hours at room temperature, depending on the concentration of lead peroxide curing agent and stearic acid. Curing continues for days or weeks, during which time properties of the material gradually reach their ultimate values.

Plastisols — Because of their elastomeric properties, plastisols are used—to a limited extent—as encapsulating compounds. Their most notable use has been on wire-wound toroidal cores to provide mechanical protection.

The plastisols consist of finely divided particles of polyvinyl chloride suspended in one or more ester-type plasticizers. Metallic compounds are usually added as stabilizers to improve heat resistance, and pigments are often added to improve appearance and to lessen degradation by ultraviolet light. When properly compounded the materials have good resistance to normal atmospheric aging.

Depending on the volume heated, liquid plastisol is converted to a rubbery solid in 10 min to 2 hr at 300 to 350 F. This elevated temperature fuses or solvates the solid particles of resin in the plasticizer.

Urethanes — Elastomeric urethane potting and encapsulating materials are noted for their strength, toughness, durability and abrasion resistance. They are prepared by curing liquid urethanes with polyamines or hydroxyl-containing materials such as castor oil. One of the problems with these materials is that the

ENCAPSULATION MATERIALS[a]

	Flexibilized Epoxies			Liquid Elastomers				Rigid Polyurethane Foams	
	Epoxy-Polysulfide (50-50)	Epoxy-Polyamide (50-50)	Epoxy-Polyurethane (50-50, diamine cure)	Polysulfide	Silicone	Polyurethane (diamine cure)	Plastisol	Prepolymer	One-Shot
	350	430	640	340	400	350	200	—	—
	5.6	3.2	—	7.2	3	8.2	5.6	1.05	1.07
	5.4	3.2	4.9	7.2	3	7.3	4.9	1.06	1.06
	4.8	3.1	—	7.2	3	—	3.6	1.04	1.02
	0.02	0.01	—	0.01	0.005	0.08	0.12	0.004	0.004
	0.02	0.01	0.04	0.01	0.004	0.09	0.1	0.003	0.002
	0.06	0.02	—	0.02	0.003	—	0.12	0.003	0.001
	10^{12}	10^{14}	—	10^{11}	10^{13}	—	10^{10}	$>10^{12}$	$>10^{12}$
	10^{10}	—	—	10^{10}	10^{12}	—	10^{10}	$>10^{12}$	$>10^{12}$
	10^{12}	10^{14}	10^{14}	10^{11}	10^{14}	10^{12}	10^{10}	$>10^{14}$	$>10^{14}$
	1,800	4,600	6,000	800	275	4,000	2,400	110	390
	30	—	10	450	200	450	300	—	—
	—	7,000	—	—	—	—	—	85	400
	—	8,300	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—
	40D	—	80D	45A	35A	90A	80A	—	—
	—	—	—	—	—	—	—	—	—
	3	3	6	1	2	4.5	—	—	—
	1.2	1.0	1.2	1.2	1.1	1.1	1.2	0.1[c]	0.16[d]
	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—
	—	—	100	—	—	—	—	—	—
	225	175	250	200	350	210	150	165	250
	44	44	110	—	128	110	—	19	19
	—	—	0.77	—	0.13	—	0.09	0.02	0.02
	0.90	0.80	1.10	0.85	4.25	1.30	0.30	1.75	3.00

reactants must be kept dry to prevent the formation of bubbles and foam. Thus, the ingredients have to be protected from moisture pickup in the air.

Foams

All three types of foams—rigid, semi-rigid and flexible—can be used for potting and encapsulating components. They are particularly useful in applications where it is desirable to reduce weight. For this reason they are especially valuable in airborne military applications. Rigid and semi-rigid foams are usually used in such applications to minimize movement of components during shock and vibration. A flexible foam may be used in addition to completely encompass and cushion the potted or encapsulated product.

Foams should preferably be used with components that do not generate heat. Heat may not be a factor in short-life applications, but normally provision must be made for conducting it away.

Rigid polyurethane foams with densities of 6 to 10 lb per cu ft are generally used for potting and encapsulation. These foams can be produced by two methods. In the one-shot method the foam is produced by simultaneous mixing of all the ingredients—the polyol, diisocyanate, water, catalyst and dispersing agent. In the second, or prepolymer, method the diisocyanate is reacted with the resin to produce a somewhat viscous prepolymer. This prepolymer can be reacted immediately with water in the presence of a catalyst and dispersing agent to form foam. Or it can be stored and used at a convenient time.

An important advantage of the prepolymer method is that since the diisocyanate has previously been reacted with the polyol, volatility and toxicity of the diisocyanate are reduced in the foaming operation. In addition, prepolymer foams generate less exothermic heat than one-shot foams during foaming, the polyester-diisocyanate exothermic reaction having already been completed. Thus, a prepolymer foam is desirable where only low exotherms can be tolerated.

Now you can Determine Minimum Bend Radii from Standard Tensile Test Results

Two simple formulas, mathematically derived, require only reduction of area values. Correlation is close.

by J. Datsko and C. T. Yang,
University of Michigan

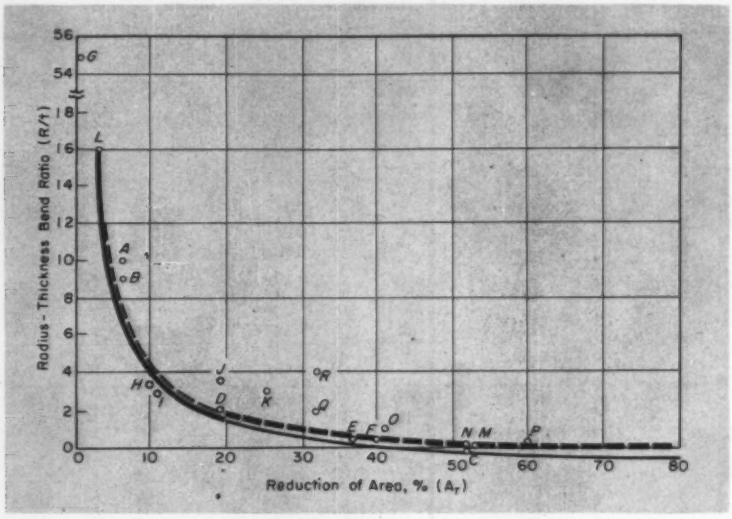
■ With the increased use of high temperature materials that require sheet-metal forming, it is important to treat the subject of minimum, or "critical," bend radius analytically. The following equations (see box for derivations) mathematically relate minimum bend radius, R, to percentage reduction of area, A_r, for any thickness, t:

If $A_r < 20$: $R/t = (50/A_r)-1$
If $A_r > 20$: $R/t = (100-A_r)^2/(200\ A_r-A_r^2)$.

The two curves of the graph are plots of these two equations. Each is plotted for all values of A_r to show that the simpler equation (solid line) is sufficiently valid for values of A_r below 20. For values of A_r greater than 20 the difference in the two curves becomes significant and the more complex formula must be used. The changeover at $A_r = 20$ was decided upon by experience.

Graph probably valid for all materials

From the graph, then, the minimum bend radius can be determined for any material for which the percentage reduction of area is known. Although experiments with plastics were too limited to allow valid conclusions, it would seem that the equations will be equally valid for nonmetals. The theory behind the derivation does not relate to the nature of the materials. However, when dealing with very elastic materials that have no plasticity, the elastic springback must be considered.



Bend test points *plotted on graph with mathematically determined curves show good correlation of theory developed in this article.*

MATERIALS TENSILE TESTED TO VERIFY BEND-TENSILE RELATION

Code	Material	Specific Alloy	Number Tested[a]	Original Thickness (t), in.	Reduction of Area, %[b]	R/t
A	Aluminum	2011-ST6	3	¼	6.2, 8	10
B		2011-ST6	3	⅛	6.4	9
C		1100-H	3	¼	52	0.06
D	Brass (50% CW)	70-30	1	¼	19, 41	2
E	Brass		3	¼	37, 50	0.5
F			3	⅛	40	0.55
G	Cast iron		1	5/64	¾	55
H	Magnesium	Tooling Plate	3	¼	9.9, 10.2	3.5
I			3	⅛	11	3
J		AZ31BH	3	0.050	19	3.7
K		HK31X1	3	0.032	25	3
L	Polystyrene		1	⅛	3	16
M	Steel	1018	3	¼	53, 57	0.2
N			3	⅛	52	0.2
O	Tool steel	B & S	2	¼	41	1.0
P			2	⅛	60	0.4
Q	Titanium	130B	2	¼	32, 39	2
R			2	1/16	32	4

[a] Number of *flat* specimens only.
[b] Where two values are given, the second was obtained from ½-in. dia round stock but the test value was not used in plotting points on the graph.

For example, CR39 is an allyl ester cast sheet commonly used in in photoelasticity studies. As normally tested it has a zero percentage reduction of area. Nevertheless, a ⅛-in. sheet can be bent to a 2-in. radius before it fractures. After breaking, the bend specimen is perfectly flat, indicating complete springback. Therefore, in conducting the tensile test, the actual area must be measured just prior to fracture. If this is done, a 3% reduction

of area will be found; with this correction CR39 would also fit the curve of Fig 1.

Bend tests confirm curves

To confirm the mathematical analysis, tensile and bend tests were conducted on a number of materials. The results of these tests are given in the accompanying table. In most cases, three specimens of each were tested but, since the range was small, only the averages are reported here. The resultant points were plotted along with the theoretical curves on the graph. The correlation was good enough to bear out the theory.

Testing procedure—Flat tensile specimens were cut from magnesium, aluminum, brass, steel, titanium, cast iron and polystyrene bar stock. A 30-ton universal tensile testing machine was used to pull the specimens until they fractured. Cross-sectional areas of the specimens were measured before testing and after fracture. Though the data was not used in plotting the points on the graph, some round tensile specimens were tested to determine the agreement between the two shapes of specimens.

In the bending test two methods were tried. In the first, the flat, rectangular specimen was supported horizontally on two rolls and the load was applied vertically between them by a third roll. During the test it was necessary to stop loading at regular intervals and search for small cracks on the outer fibers. When cracks appeared, the inner radius of the bent beam was measured by radius gages.

In the second method, the specimen was held upright in a vise clamped on one end. A bending moment was applied to the other end. The two methods gave similar results and the second, which is quicker, was used to obtain the results reported here.

Correlation analyzed

It is apparent from the graph that most of the experimental data points fall reasonably well along the theoretical curves.

For the soft brasses, aluminum and steel, percentage reduction of area is greater than 50. The theoretical curves predict that these materials can be bent to an R/t ratio approaching zero, and this is substantiated in practice. These ductile materials can be bent double with one face in contact with itself without any cracks appearing.

Another interesting point borne out by the tests is the relationship between aluminum, usually considered quite ductile, and thoriated magnesium, usually considered quite brittle. By comparing points A and B to J and K it can be seen that, as the theoretical curve approximately predicted, aluminum alloy 2011 ST6 can be bent to an R/t of only 9 or 10 while the magnesium alloy can be bent to an R/t of 3 or 4.

The one plotted point that seems to show bad correlation is that for the two 3/16-in. RC130B titanium alloy specimens. The fact that this point is much further off the theoretical curve than the single ¼-in. specimen of the same alloy, however, would suggest that some unusual factor was involved—and this was found to be the case.

The first ¼-in. piece was difficult to bend and the second and third specimens were therefore machined down to 3/16 in. by making one heavy cut on each side. The ¼-in. pieces had been machined from a ½-in. thick piece by several light cuts. It is believed that the discrepancy in the test values of the 3/16-in. pieces resulted from the residual tensile stresses set up during the heavy machining cut.

The Mathematical Derivation

To arrive at the formulas used to plot the curves in this article, the following assumption was used: The fracture strain in the outer fiber of a bending specimen is equal to the true strain in a tensile test specimen.

By definition, the true strain at fracture of a tensile specimen is equal to: ln (l_f/l_o), where l_f and l_o are the final and original lengths respectively. If the volume is assumed to constant, the relationship can be expressed as ln (100/100-A_r), where A_r is the percentage reduction of area.

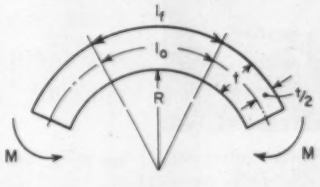
Bending strain equated to tensile

Consider a flat sheet subjected to a bending moment. The outer fiber is strained in tension and the inner fiber in compression. Inasmuch as failure will not occur on the compressive side, only the strain in the outer fiber will be considered.

1. If the neutral axis of the bend is assumed to lie in the center of the sheet thickness, the mathematics are simplified. The true strain in the outer fiber, e_o, is equal to ln (l_f/l_o). Because l_f and l_o are arc lengths, their ratio equals the ratio of their radii, or: $l_f/l_o = (R+t)/(R+t/2)$. Thus: $e_o = \ln (R+t)/(R+t/2) = \ln (100/100-A_r)$. Solving for R/t yields:

$$R/t = (50/A_r) - 1.$$

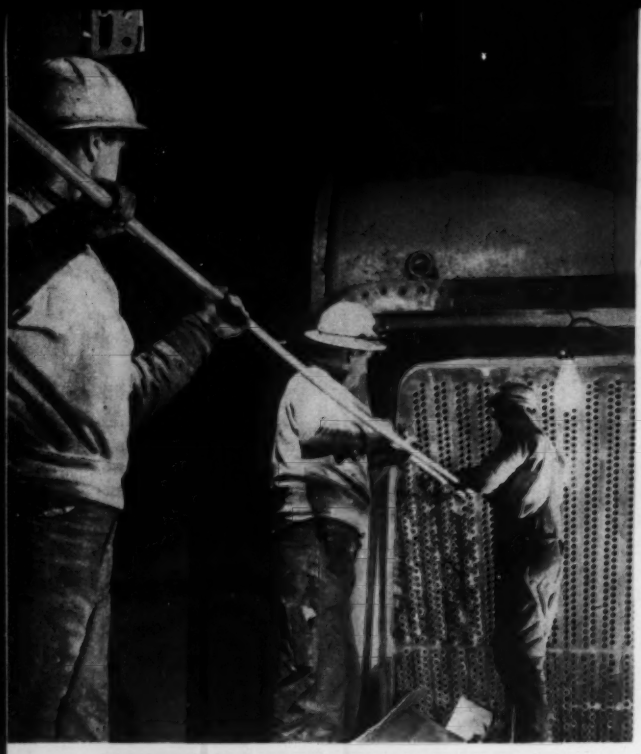
It was found that this relationship is valid for materials having a percentage reduction in area of less than 20.



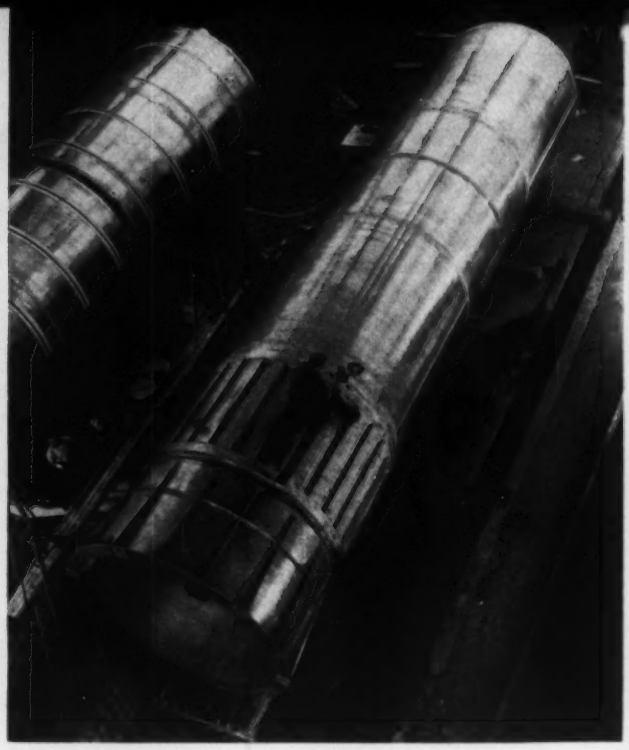
2. For materials having a percentage reduction in area greater than 20, the displacement of the neutral axis in bending is significant. The equations must now consider the radius of the neutral axis, which can no longer be assumed equal to R + (t/2). Omitting the involved mathematical manipulations, the final equation is:

$$R/t = (100-A_r')/(200\ A_r-A_r')$$

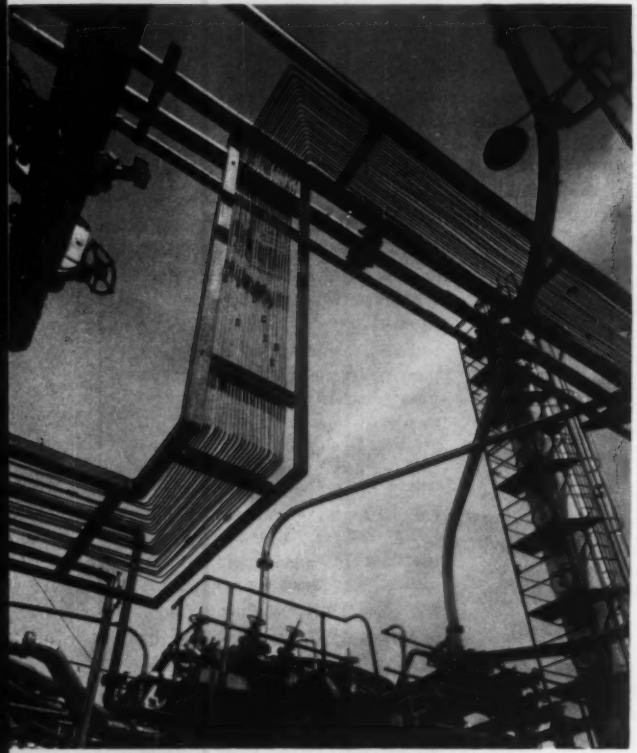
Although not mentioned in the text and not used to plot curves, an empirical relationship: R/t = (60/A_r) – 1 has also been found satisfactory for ductile materials that do have a shift in neutral axis.



Steam condenser tubes *of aluminum for power generation equipment have gained rapid acceptance.*



Storage tanks *of aluminum prevent discoloration of chemical ingredients for synthetic textiles.*



Instrument air lines *made from aluminum offer substantial savings in initial cost and freedom from corrosion by atmospheric hydrogen sulfide.*

Selecting Aluminum Alloys for Process Equipment

Because of their excellent strength-to-cost ratio and resistance to corrosion, aluminum alloys are becoming increasingly popular for processing chemicals, petroleum products, foods and drugs. Here are the alloys to use, corrosion factors to consider, and a look at costs.

by R. L. Horst, Jr., *Aluminum Co. of America*

What alloys are best?

Aluminum alloys for processing equipment fall into two groups: non-copper-bearing and copper-bearing alloys. The non-copper-bearing alloys have the same high corrosion resistance as commercially pure aluminum alloys and, because of their high strength, are widely used for processing equipment. Although the copper-bearing alloys (the 2000 series) have exceptionally high strength, their corrosion resistance is relatively low. Thus, they are rarely used for processing equipment except as fasteners or for structural parts not subject to corrosive environments.

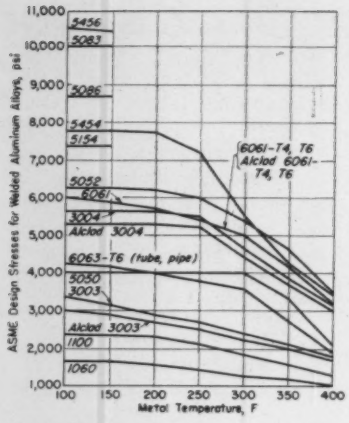
Table 1 shows the wrought alloys most frequently used for processing equipment with a description of their main features and a checklist of available forms. These alloys all have essentially the same corrosion resistance. However, their mechanical properties (available from standard handbooks) vary widely and should be checked. In general, use of the higher strength alloys will result in a lower cost for pressure vessels, structural supports or field erected storage tanks. On the other hand, the lower strength alloys are more economical for less demanding applications such as vented tanks or jacketing for thermal insulation.

Alloys for pressure vessels

Most aluminum alloys for pressure vessels are included in stand-

TABLE 1—STANDARD WROUGHT ALUMINUM ALLOYS FOR CHEMICAL AND PROCESS EQUIPMENT

Alloy ↓	Available Forms							Main Features
	Sheet, Plate	Wire, Rod, Bar	Rolled Shapes	Extruded Shapes	Tube, Pipe	Rivets	Forgings	
EC		X	X					Busbar alloy, good electrical conductivity
N02EC			X	X	X			High strength busbar alloy
1060	X	X			X			For hydrogen peroxide service. Used where minimum catalytic action is required
1100	X	X				X	X	Commercially pure alloy. Standard welding wire for 1100 and 3003 alloys
1260	X	X						Standard welding wire for 1060 and 1260 alloys
2024		X						High strength nuts and bolts. Needs protection in corrosive environments
2117		X				X		High strength rivets. Needs protection in corrosive environments
3003	X	X		X	X		X	Standard general purpose alloy
3003 (Alclad)	X				X			Same as 3003. High resistance to perforation
3004	X							Same as 3003 with higher strength but is harder to weld
3004 (Alclad)	X							Same as 3004 with higher resistance to perforation
4043		X						Standard welding wire
5005	X							Standard sheet and plate alloy, interchangeable with 3003
5050	X				X			Standard general purpose alloy
5052	X	X			X			Moderate strength, general purpose structural alloy
5056		X				X		Screens, fences, rivets
5056 (Alclad)		X						Same as 5056 with higher resistance to perforation
5083	X							High strength structural alloy (up to 150 F)
5086	X	X		X	X			Same as above
5154	X	X		X	X			Same as above
5254	X	X		X	X			For hydrogen peroxide service (up to 150 F)
5454	X	X		X	X			High strength high temp structural alloy
5456	X	X	X	X	X			High strength structural alloy (up to 150 F)
5554		X						Best welding wire for 5454
5556		X						Best welding wire for 5456
5652	X	X			X			For hydrogen peroxide service
6053						X		Moderate strength rivets
6053 (Alclad)	X						X	Beer barrels, shipping drums
6061	X	X	X	X	X	X	X	Moderate to high strength, general purpose structural alloy
6061 (Alclad)	X			X	X			Same as 6061 with higher resistance to perforation
6062				X	X			Interchangeable with 6061, slightly lower cost
6062 (Alclad)					X			Interchangeable with Alclad 6061; slightly lower cost
6063				X	X			Low cost, moderate strength extrusion alloy
6063 (Alclad)					X			Same as 6063 with higher resistance to perforation
6151							X	High strength forgings
6363				X	X			For hydrogen peroxide service



1 Design stresses *for welded alloys at temperatures up to 400 F.*

ard design codes, such as the ASME code for unfired pressure vessels, HEI standards for heat exchanger tubes, and API specifications for field-erected storage tanks. Design stresses for typical alloys are given in Fig 1, taken from Section 8 of the ASME code. This code limits aluminum alloys to temperatures below 400 F.

Mechanical properties and design suggestions for temperatures over 400 F are readily available from aluminum producers. For example, heated reactors and heat exchangers of aluminum are used in resin production at temperatures over 625 F. And phosphorus pentasulfide is produced in aluminum equipment operating near 700 F.

For pitting: alclad alloys

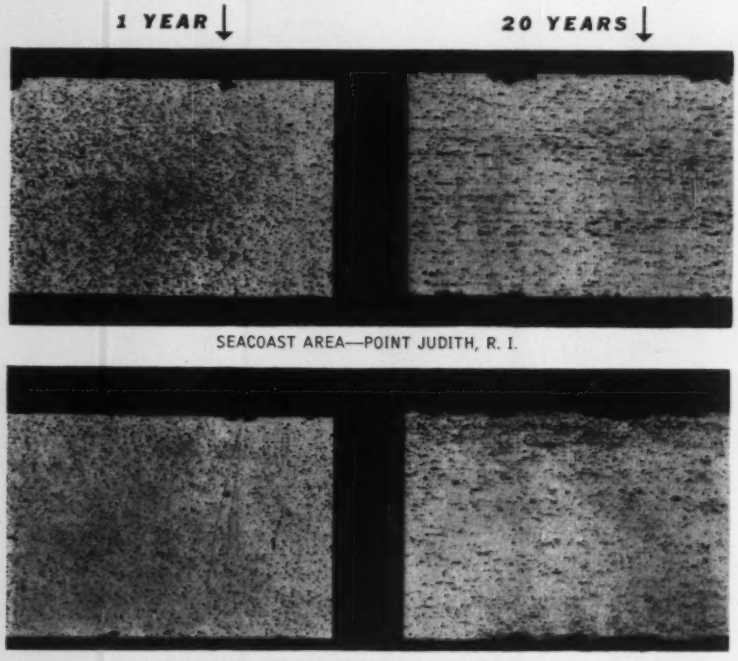
Alclad alloys are desirable where thin sections are exposed to a pitting environment. They are actually composed of two alloys: a core and a metallurgically bonded cladding. The core is selected for its formability, strength or weldability, and the cladding is selected to be anodic to the core.

If a pit starts in an alclad alloy the depth of attack is limited to the clad layer. Penetration of the core does not start until all of the cladding in the adjacent area is consumed. Even then, penetration of the core will not start until the diffusion zone, which is also anodic to the core, is consumed in the pit area. Alclad can extend the life of equipment considerably in applications where a pitting type of attack is expected. However, the lower cost bare alloys are recommended where pitting does not occur or where experience has proved it to be insignificant.

Cladding thickness is expressed as a percentage of the total wall thickness or cross section. A typical figure is 10%. The cladding alloy can be applied to one or both sides of sheet, plate, tube or pipe (see Table 1).

How good is corrosion resistance?

Although aluminum is popularly noted for its light weight, designers of process equipment are more impressed by its high resistance to corrosion. Aluminum's corrosion resistance depends on an oxide coating that forms instantaneously in air. Although thin, this coating is highly adherent and resists dissolution or breakdown under many conditions.



2 High atmosphere resistance *of aluminum—in both coastal and industrial atmospheres—is shown in these cross sections of exposed specimens.*

Resistance to atmosphere

In corrosive atmospheres, aluminum undergoes an initial action that is self-stopping. Cross sections of exposed aluminum (Fig 2) illustrate this property which is characteristic of the metal in practically all atmospheric applications. Even though the surface may become dulled, structurally significant corrosion does not occur and the surface requires little maintenance. A large number of successful applications requiring little maintenance testify to this fact—roofing, siding, handrails, window frames, fencing, and weatherproofing for thermal insulation.

Resistance to chemicals

Aluminum, like lead, tin and zinc, is an amphoteric metal. For some, this has led to the erroneous conclusion that aluminum cannot be used to handle acid or alkaline solutions. As Fig 3 shows, pH alone is not a criterion. What is causing the pH is more important.

The key is that in solutions corrosive to aluminum, the aluminum oxide film is dissolved; in the noncorrosive solutions, the film is inert or forms stable compounds. Glacial acetic acid, fuming nitric acid, hydrocyanic acid, and ammonium hydroxide solutions are among those commonly handled and shipped in aluminum equipment or tank cars. Other major commercial chemicals that can be handled or shipped in aluminum equipment are listed in Table 2.

Preserving product color and purity

There are many processes where the color and purity of the final product must be preserved. For example, polyethylene, polystyrene and nylon salts must be kept free from discoloration. Similarly, cosmetics, essential oils and foods must contain no harmful contaminants. As shown in Table 3, aluminum is particularly valuable in processing such materials. Even in those cases where a small amount of corrosion occurs, no discoloration or contamination takes place.

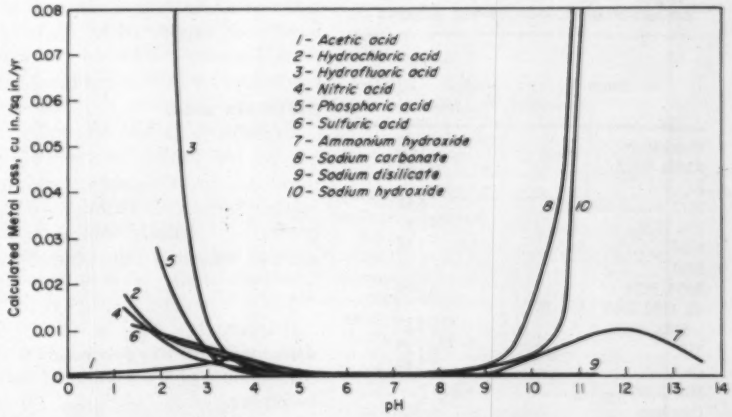
TABLE 3—MATERIALS THAT CAN BE HANDLED IN ALUMINUM TO AVOID UNWANTED COLOR

COSMETICS	Ammonium thiocyanate
Ammonium thioglycollate	Calcium hypochlorite
Dyes, pigments	Catalytic fluorphosphates
Glycerol	Phosphor suspensions
Soaps	Potassium pyrophosphate
Starches, gums, resins	Titanium dioxide
ESSENTIAL OILS	PHARMACEUTICALS
Acetophenone	Aspirin
Benzyl acetate	Chloromycetin
Lemongrass oil	Stryptomycetin
Linalyl acetate	PLASTICS AND RELATED MATERIALS
Methyl salicylate	Acrylonitrile
Oil of wintergreen	Adipic acid
Peppermint oil	Cellulose acetate
FOODS	Ethyl benzene
Cocoa, chocolate	Hydrogen cyanide
Edible oils	Isothiocyanates
Fish	Nylon salts
Flour	Phenol-formaldehydes
Gelatin	Phthalic anhydride
Margarine	Polyethylene
Oils, fats, lard	Polymethyl methacrylate
Salt	Polypropylene
Soluble coffee	Urea-formaldehydes
Sugar	Vinyl acetate
Yeast	Vinyl chloride
INORGANIC CHEMICALS	
Alum	

TABLE 2—CHEMICALS THAT CAN BE HANDLED BY ALUMINUM ALLOYS•

Acetaldehyde	Cyclopropane	Napthalene	Propane
Acetic acid	Dextron	Naphthenic acids	Propionic acid
Acetic anhydride	Dextrose	Nitric acid (fuming above 82%)	Propionic anhydride
Acetone	Dichlorobenzene	Nitrocellulose	Propyl alcohol
Acrolein	Dichlorodifluoromethane	Nitrogen fertilizer solns	Propylene glycol
Acrylonitrile	Ester gum	Nitroglycerine	Pyridine
Adipic acid	Ethyl acetate	Nitrous oxide (dry)	Ricinoleic acid
Alcohols	Ethyl acetoacetate	Nylon salts	Rosin
Aldol	Ethyl alcohol	Oils	Salicylic acid
Ammonia	Ethylene glycol	Edible	Shellac
Ammoniated ammonium nitrate solns	Fatty acids	Essential	Sodium bicarbonate
Ammonium nitrate	Formaldehyde	Fuel, lube, transformer	Sorbitol
Ammonium thiocyanate	Freons	Tall	Starch
Aniline	Furfural	Oleic acid	Stearic acid
Benzaldehyde	Gasoline	Oxygen	Styrene monomer and polymer
Benzene	Glucose	Paraldehyde	Sugar
Benzoic acid	Glycerine	Pentaerythritol	Sulfur
Butyl acetate	Helium	Pentaerythritol tetranitrate	Sulfur dioxide
Caprylic acid	Hexamine	Pentane	Tar
Carbon dioxide	Hydrocyanic acid	Perchlorethylene	Titanium tetrachloride
Carbon disulfide	Hydrogen	Petroleum gas	Toluene
Carbonic acid	Hydrogen peroxide	Phosphorous pentasulfide	Triacetin
Castor oil	Isobutyric acid	Phthalic acid	Trichlorobenzene
Cellulose acetate	Lacquers and their solvents	Phthalic anhydride	Trichloroethylene
Cement	Linseed oil	Picric acid	Urea
Cod liver oil	Maple syrup	Polyethylene	Vinyl acetate
Corn syrup	Methane	Polystyrene	Vinyl chloride
Cresol	Methylethyl ketone	Potassium nitrate	Water
Cresote	Methyl salicylate		High purity
Crotonaldehyde	Monochlorodifluoromethane		Saline
Cyclohexane			Tap

•In general, those alloys listed in Table 1.



3 ***Corrosion resistance*** *of aluminum exposed to chemicals of varying pH.*

Steam-carrying pipeline *is protected from weather by jacket of aluminum. Over 80,000 lb of sheet are used in 5½-mile system.*

What about contact with other metals . . .

In most galvanic corrosion problems the rate of corrosion at the anode depends on the relative effective areas of cathode and anode. For good corrosion resistance the designer should strive for a large anode area coupled to a small cathode area. The design of riveted or welded structures is an application of this principle. Care should be taken to minimize the potential difference between the rivets or welds (they should be made slightly cathodic) and the structure.

Caution is required if paints are used to prevent galvanic corrosion. The first thought may be to paint only the anode—the metal that is corroding. This practice must be avoided as it only tends to intensify attack at pinholes, holidays or scratches in the coating. Proper practice is to coat the cathode, the metal that is not corroding. This reduces the current demand on the anode and thereby reduces the rate of corrosion.

With a few exceptions (e.g., coupling with austenitic stainless steels) it is good practice to select materials with about the same solution potentials. Solution potentials for a number of metals in a sodium chloride solution are given in Table 4. These potentials can vary with the electrolyte but will remain approximately in the order shown.

TABLE 4—ELECTRODE POTENTIALS OF ALUMINUM AND OTHER ALLOYS

Alloy[a] ↓	Potential, (0.1N Calomel Scale)[b]
Magnesium	−1.73
Anode Plate	**−1.05**
Zinc (99.2%)	−1
7072, Alclad 3003	**−0.96**
214, 5056	**−0.87**
5154	**−0.86**
5052	**−0.85**
B214, 3004	**−0.84**
43, 1100, 3003, 6151, 6053, 6061, 6063	**−0.83**
356	**−0.82**
Cadmium	−0.82
Mild Steel	−0.53 to −0.67[c]
Cast Iron	−0.66
Lead	−0.55
Stainless Steel (13% Cr)	−0.52
Tin	−0.49
Brass (60-40)	−0.28
Copper	−0.2
Bismuth	−0.18
Stainless Steel (18-8 types)	−0.08 to −0.19[c]
Aluminum Bronze	−0.15
Monel	−0.1
Bronze, Silver	−0.08
Nickel	−0.07
Inconel	−0.06
Chromium	−0.4 to +0.18

[a]Bold-faced alloys are aluminum.
[b]Measured in aqueous solution of 53 gm NaCl + 3 gm H_2O_2 per liter.
[c]Potential varies with alloying constituents.

Mild steel

Since aluminum cannot be welded to steel, the metals have to be joined by mechanical fasteners or resin bonding. As the dissimilar metal joints may have a crevice which is a potential moisture trap, it is good practice to calk, gasket, tape or paint faying surfaces. The need for such protection depends on the corrosiveness of the environment. For example, exposed steel-aluminum joints on ship exteriors have to be protected. On the other hand, indoor installations of aluminum conduit or pipe have been supported by unpainted steel fasteners with no corrosion occurring on faying surfaces.

Stainless steel

Protection is not normally required for joints between aluminum and the 300 series stainless steels. Some good examples of unprotected dissimilar metal couples are: 1) stainless steel screws used to hold aluminum sheets or plates where the strength of aluminum screws is inadequate, 2) stainless steel trim on aluminum valve bodies, and 3) stainless steel nuts and bolts used to fasten aluminum anodes to steel for cathodic protection in sea water.

In good electrolytes like sea water the anode/cathode area ratio should be high. Some form of protection should be provided where a small area of aluminum must be coupled to a large area of stainless.

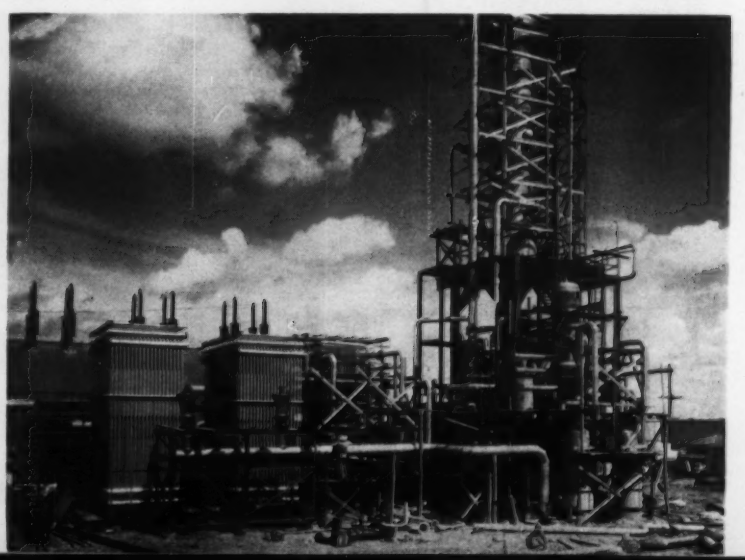
Copper

This couple is an invitation to corrosion in most wet process environments. If the two metals are to be used together a corrosion engineer should review the design to advise on protection. Some joint designs are acceptable, notably the coupling of aluminum and copper busbars with a proper joint compound and Belleville washers.

Mercury

Mercury contamination can cause serious corrosion on equipment made of nonferrous alloys. It tends to localize attack on aluminum-base alloys. Corrosion is believed to be caused by an amalgamation of mercury with the alloy which either alters the solution potential of the alloy or prevents formation of an adherent oxide film. Thus, extreme care is required when using mercury

All-aluminum oxygen plant *features harp-type heat exchangers (left center) containing dip-brazed assemblies with thousands of tiny fins for maximum heat transfer.*



manometers, thermometers and other instruments.

'Heavy metals'

The presence of heavy metals is a special case of dissimilar metal contact. Some electrolytes may contain small amounts of heavy metal ions such as copper, nickel, lead or cobalt. When these ions are handled in aluminum they can electrodeposit on surfaces and set up tiny galvanic cells, resulting in pitting. This type of corrosion can be minimized by using an alclad alloy. Also, the heavy metal ions can be removed from solution by plating them out in a container filled with aluminum chips, mesh, or Raschig rings placed upstream from the aluminum equipment.

. . . and contact with nonmetallics?

Thermal insulation

Many thermal insulations, such as borosilicate glass fibers, calcium silicate and 85% magnesia, are compatible with aluminum. However, calcium silicate and 85% magnesia are good electrolytes and, when wet, will promote galvanic corrosion when in contact with aluminum-steel couples. Thus, to avoid the possibility of galvanic action with wet insulation, practically all aluminum weatherproofing is installed with an underside moisture barrier, usually made of asphalt-treated kraft paper or polyethylene-coated paper.

Concrete

Aluminum embedded in concrete suffers only superficial corrosion during setting and further action is stifled once the concrete has hardened. The same holds true for aluminum-steel couples in concrete, and there are many applications where aluminum is embedded in concrete and tied to reinforcing steel with no deleterious effects. Addition of chlorides to mortar causes some attack; this can be avoided by using other quick-setting additives that do not make concrete corrosive.

How does aluminum compare in cost?

At present prices aluminum alloy plate costs 45 to 55¢ per lb, 316 stainless 81¢ per lb, and copper 57¢ per lb. Table 5 shows comparative costs of these metals when used in ASME pressure vessels designed for use at 150 F. These figures, which take into account differences in specific gravity and allowable design stresses, show the cost advantage of using aluminum. Labor and overhead costs are not included but they can be assumed to be about the same regardless of the metal used.

Similar calculations for an operating temperature of 300 F show that 304 and 316 stainless are respectively 11% and 46% more expensive than 5454 aluminum. Actually, 5052 alloy is the best buy at 300 F, costing 4% less than 5454. At 400 F, however, 304 stainless has the lowest cost, with 5052 second. Type 316 stainless and 5454 aluminum are third and fourth, respectively.

Aluminum heat exchanger tubes are less expensive than carbon steel tubes in sizes under 1 in. o.d. Table 6 gives cost comparisons made in the sum of 1959 for one popular tube size, ⅝ in. o.d. x 0.049 in. wall x 30 ft long. For this particular size, non-clad aluminum tubes were two-thirds the price of seamless stainless tubes; alclad 3003 tubes cost half as much as Admiralty brass and one-eighth as much as 304 stainless.

TABLE 6—COMPARATIVE COST OF ALLOY TUBING[a]

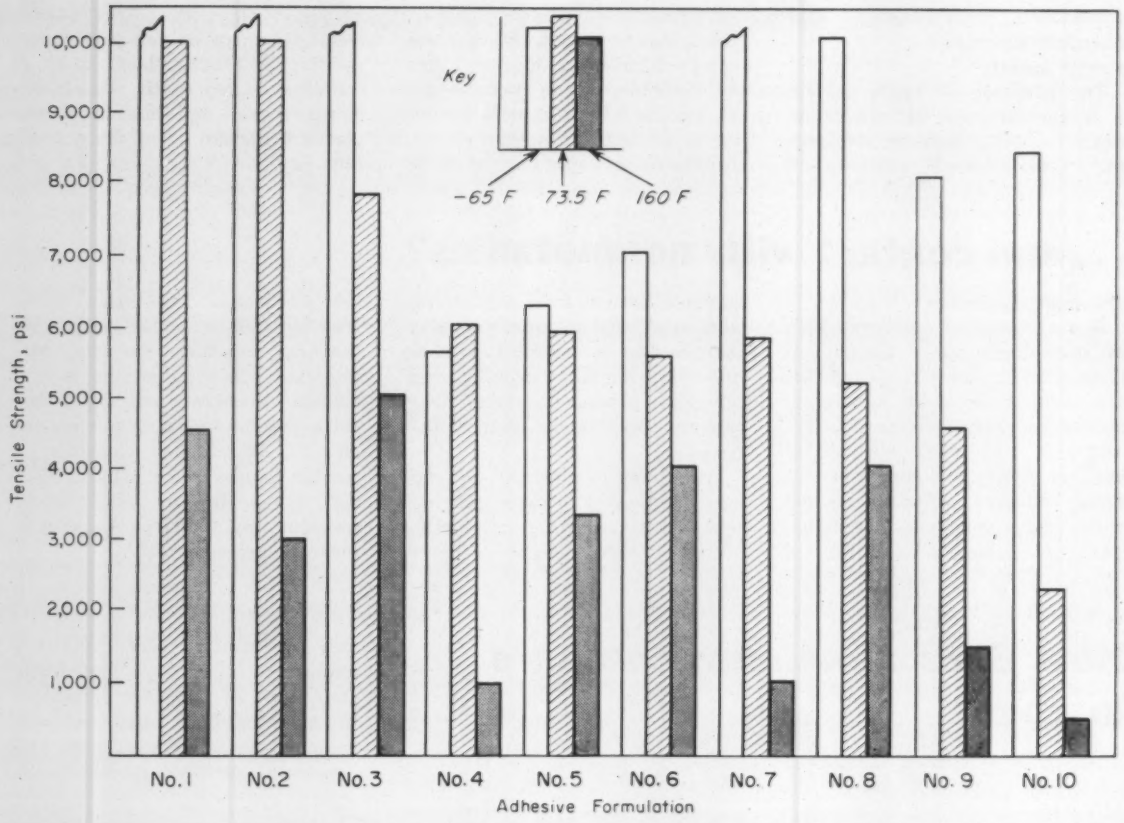
Alloy ➡	$/100 ft	Quantity Range, lb
3003-H14 Aluminum		
Not Clad	**9.80**	5-10,000
Alclad (inside)	**12.35**	5-10,000
Seamless Mild Steel, Cold Drawn	14.75	15,000
Admiralty Brass	23.60	20,000
90-10 Cupro-Nickel	29.20	20,000
304 Stainless	96.99	15,000
316 Stainless	158.84	15,000

[a] ⅝-in. o.d. × 0.049-in. wall.

TABLE 5—COST COMPARISON OF ALLOYS FOR WELDED UNFIRED ASME PRESSURE VESSELS[a]
(For Metal Temperatures up to 150 F)

Alloy ➡	5456	5083	5086	5454	5154	5052	6061-T6	3003	Stainless Steel 304	Stainless Steel 316	Copper
ASME Max Allowable Stress, psi[b]	10,400	10,000	8,700	7,750	7,350	6,250	5,900	3,150	17,700	18,750	6,700
Metal Thickness, % 5456	100	104	120	134	142	167	176	330	59	56	155
Metal Density, lb/cu in.	0.096	0.096	0.096	0.097	0.096	0.097	0.098	0.099	0.29	0.29	0.32
Vessel Weight, % 5456	100	104	120	135	142	169	180	340	178	169	520
Metal Cost, $/lb[c]	0.542	0.542	0.507	0.507	0.507	0.476	0.478	0.449	0.547	0.807	0.57
Metal Cost, % 5456	100	100	94	94	94	88	88	83	101	149	105
Metal Cost Per Vessel, % 5456[d]	100	104	113	127	133	149	159	282	180	252	546

[a] Aluminum alloys are bold-faced.
[b] From Section VIII of 1959 ASME Code.
[c] Approximate base price, Dec '59.
[d] Vessel weight (%) × metal cost (%).



***Tensile strength** of ten epoxy adhesive formulations at three temperatures. See table, p 138, for identity of adhesives. Strengths shown are the stresses required to destroy the bond when applied perpendicular to the plane of the glue line.*

An objective report on

Tensile and Impact Strengths of Ten Epoxy Adhesive Formulations

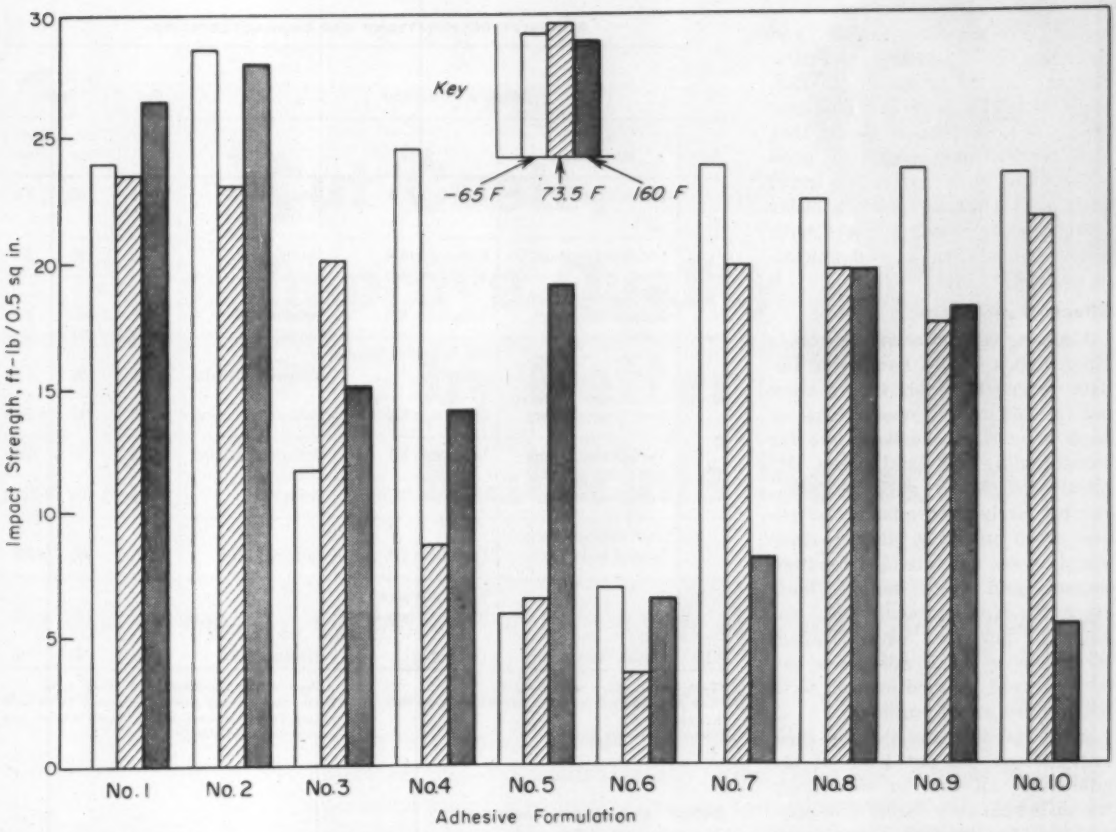
at -65 to 160 F

by M. J. Bodnar and R. F. Wegman, *Picatinny Arsenal*

■ Epoxy adhesives have superior tensile and shear strength properties. This fact has been known for some time, but it has also been recognized that their impact properties are generally inferior. These latest tests show that modifying these adhesives in various ways can improve both the shear strength and the impact resistance.

Test results applicable to other base materials

The accompanying graphs present the data obtained from a series of tensile and impact tests conducted at Picatinny Arsenal to determine the properties of ten commercial room - temperature-curing epoxy adhesives at temperatures of -65, 73.5 and 160 F. The upper and lower temperature conditions were chosen because they are the limits for which

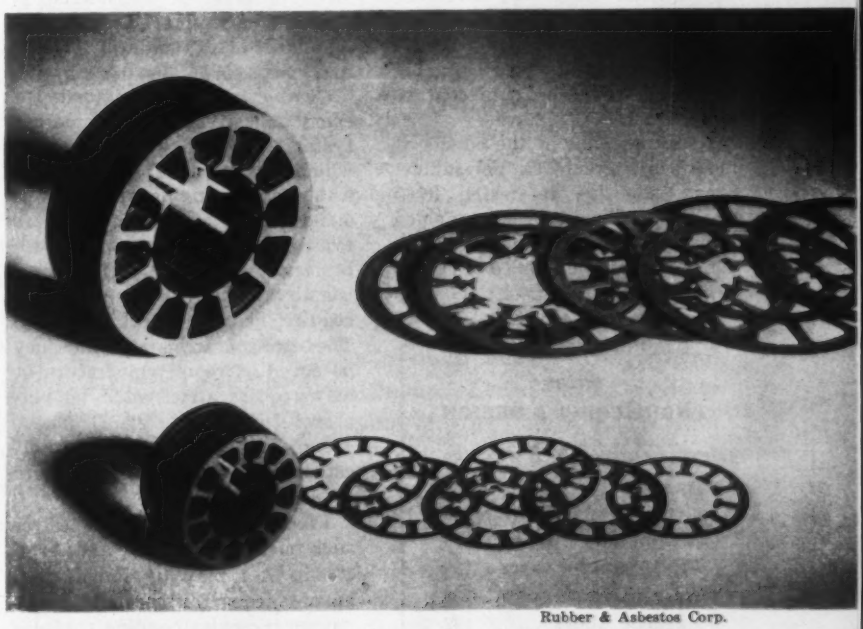


Impact strength *of ten epoxy adhesives as determined by a single blow in the shear direction of the bond.*

Army Ordnance specifies satisfactory adhesive performance.

Although these bond strength data are directly applicable only for bonding steel to steel, epoxy adhesives achieve comparable results with a wide variety of materials. Although the data cannot be directly correlated, it is likely that adhesives showing good bond strengths to steel would show reasonably good bond strengths to such metals as aluminum, nickel and titanium. Adhesives such as Epiphen 825A and Armstrong A-4, for example, would not only have high tensile, shear and impact values, but would also have good resistance to the high setback forces that are encountered in high-velocity missiles.

As for nonmetallics, it is well known that epoxies have been used successfully to bond such



Rubber & Asbestos Corp.

Metal motor laminations *are a typical use for modified epoxy adhesives.*

metals as wood, ceramics and cloth, as well as all thermosetting plastics and many thermoplastics, including TFE and polyethylene. There is no reason to doubt that the formulations exhibiting good tensile and impact-strength bonds with metals would possess similar relative ratings when tested with metal-nonmetallic or all-nonmetallic bonds.

Effect of modifiers

Unmodified adhesives such as Epon 820 and 828 have poor impact strength. Such resins were not meant to be used alone as high strength adhesives, but for compounding or laminating applications. Many adhesives that exhibit fairly poor impact strength are often unfairly judged—they simply were not intended for high impact and high tensile bond strength applications, but for general purpose use. Impact strengths of such adhesives can be improved by modification with polyamides or polysulfides.

Such modifications will, however, affect the pot lives of the adhesives, as can be seen from the accompanying table. The polyamides, for example, serve not only as modifiers but also as curing agents. They will therefore not only result in a longer pot life but also require a longer cure time before the bonded assembly can be handled or subjected to stress.

As an example of the effects of modifying agents, a polysulfide-epoxy adhesive to which 30% mineralite filler was added yielded impact values as high as 29 ft-lb per 0.5 sq in. of bonded area.

ADHESIVE DESIGNATIONS AND CHARACTERISTICS[a]

Adhesive Formulation				Pot Life, min[c]	Curing Rate, min[d]	
No.[b]	Manufacturer	Base	Additive		Tack-Free	Semi-Hard
1	Borden Chemical Co.	Epiphen 825 A	Catalyst 825 A; modifier T	75	90	150
2	Armstrong Products Co.	Armstrong A-4	Curing agent A	50	90	120
3	Shell Chemical Corp.[e]; General Mills, Inc.[d]	Epon resin 828	Versamid 140	190	>300	>300
4	—	Polysulfide-modified epoxy	Diethylenetriamine	40	90	210
5	Shell Chemical Corp.	Epon resin 820	Diethylenetriamine	80	210	>300
6	Shell Chemical Corp.	Epon resin 828	Diethylenetriamine	60	90	195
7	Protective Coatings, Inc.	Proco HR-236 B	Proco 236 C	>300	>300	>21 hr
8	Shell Chemical Corp.[e]; General Mills, Inc.[d]	Epon resin 828	Versamid 125	200	>300	>300
9	—	Polyamide-cured bisphenol-type epoxy	—	180	300	>300
10	Furane Plastics, Inc.	Epibond 1210	Hardener 9829	55	90	150

[a]Test temperature was 73-75 F.
[b]Key numbers adopted for convenience in this article.
[c]Based on 10-gm batches.
[d]Adhesive film thickness was 15-50 mils.
[e]Epon resins from Shell; Versamid polyamide resins from General Mills. These names are registered trademarks.

Other selection factors must be considered

Factors other than mechanical strength must be considered in selecting adhesives (see M/DE Manual No. 162, "Adhesive Bonding," Sept '59).

Curing type—The majority of epoxy adhesives are two-container systems consisting of a resin, which may be filled and/or modified, and a curing agent. However, one-container epoxy adhesives are available. These are usually adhesives to which the curing agent has already been added and which require heat to effect the cure. The two-container systems may be cured at room temperature or may require an elevated temperature. In general, the Ordnance design engineer is chiefly interested in those adhesives that cure at room temperature.

Viscosity — Viscous adhesives such as Epiphen P25A and Armstrong A-4 may be found most advantageous for use with items having irregular bonding surfaces or where there are broad tolerances between mating parts. However, for tight fits and smooth surfaces, a more mobile adhesive, such as Epon 828 modified with Versamid polyamide resins, may be desirable despite the lower strength.

In addition, tensile and impact properties — at temperatures to which bonded assemblies may be subjected—must be considered.

Fillers—Epoxy adhesives can be filled with metallic or other inorganic fillers to decrease shrinkage upon curing, to lower the coefficient of thermal expansion, or to thicken the consistency of the adhesive when the control of flow is required, as in filling voids or applying to vertical surfaces. Another reason for using filled epoxy adhesives may be to obtain electrical conductivity. Ordinarily adhesives prevent contact between mating metal parts and thus provide electrical insulation. When electrical continuity is desired, adhesives of the silver-filled epoxy class are often specified.

MORE ENGINEERING & DESIGN

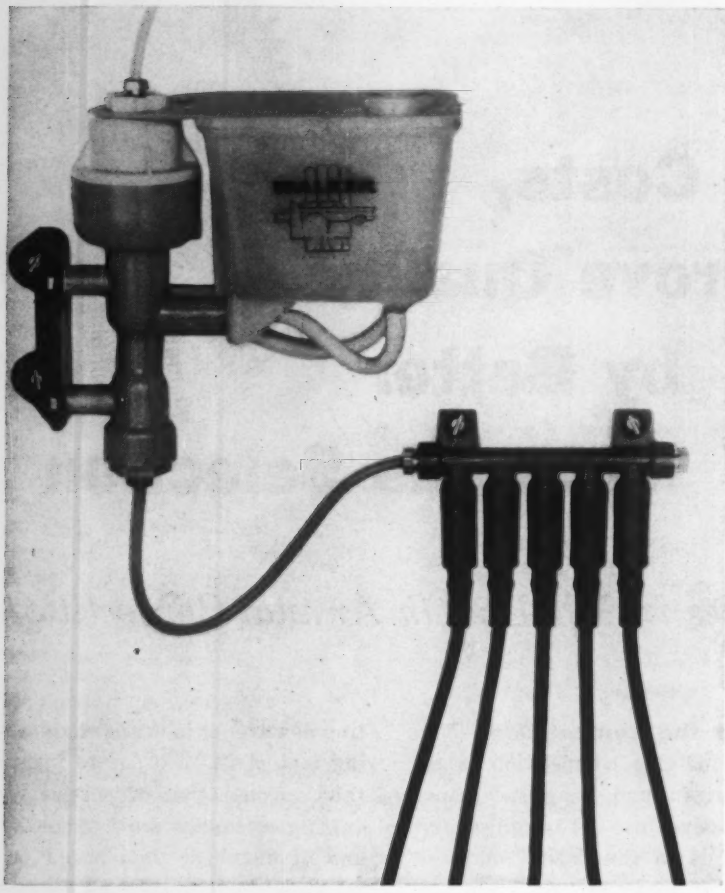
Zinc-rich paints 183
Hydrogen embrittlement 183
Printing polyester film. 184
ASTM tests for paper . 186
Wear of bronze gears.. 188
Magnetic alloys 192
Aluminum powders ... 194

Cut Costs, Improve Quality by Better Materials Selection

18 Winning Entries in M/DE's 4th Annual Competition

About the competition—The object of this competition is to encourage sound, imaginative and progressive use of engineering materials in the design and redesign of industrial and consumer products. The editors of this magazine impose no rigid restrictions on the procedures or criteria used by the judges in determining the award winners. However, the following factors are certainly among the most important considered: 1) importance of materials selection in the design, 2) degree of competence and thoroughness in materials selection, 3) degree of success achieved in meeting service requirements or improving old design, and 4) significance of entry in terms of setting new trends in use of engineering materials. In order to insure fair consideration of entries requiring a smaller scale of design and development than major entries, the judges split all entries into two groups depending upon their complexity and evaluated each group separately. Therefore, the award-winning products discussed on the following pages encompass a wide range of size and complexity. This year the judges awarded two First Awards ($500 each), six Awards of Merit ($100 each) and ten Citations ($50 each). Judges were Joseph L. Bonanno, Lionel Corp.; W. A. Irvine, Maytag Co.; N. E. Promisel, Bureau of Naval Weapons, Dept. of the Navy; and I. V. Williams, Bell Telephone Laboratories.

M/DE Special Report No. 170—May, 1960



Automatic lubricator *for vehicles is designed for low cost production.*

Automatic Lubricating System Makes Wide Use of Plastics

$500 FIRST AWARD
William G. McKenzie
and Richard D. Ritter,
Walker Mfg. Co., Racine, Wis.

■ By adopting a new metering and injection principle, and by taking maximum advantage of some of the newer nonmetallic materials, Walker Mfg. Co. has developed a greatly improved central automatic lubricator.

Because this automatic lubricating system was designed for a number of different vehicles, such as automobiles, farm machinery and off-the-road equipment, materials had to be selected that would satisfy a wide range of conditions. The most important conditions were:

1. Temperatures ranging from —25 to 225 F.
2. Contact with mineral lubricants.
3. Operating pressures ranging from 40 to 90 psi.
4. Good moldability.
5. Low cost.

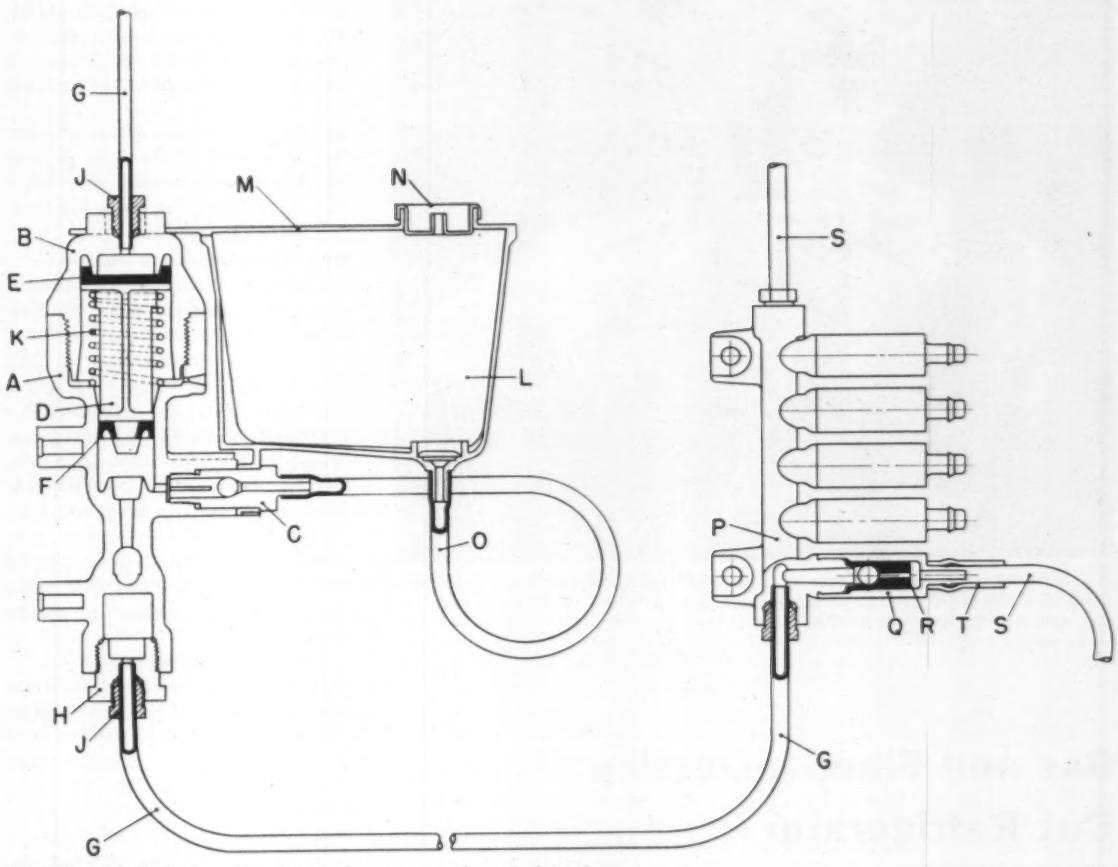
Many materials were studied to find the ones that would best meet these requirements. Plastics were given special attention because of their good oil resistance, light weight and suitability to high production manufacturing techniques. Acetal, nylon, polyvinyl chloride and ABS resins were selected in the final design.

Pump assembly

Four parts of the pump assembly—the pump body *(A)*, cap *(B)*, check valve *(C)*, and tube connector (not shown) — are injection moldings of acetal plastic. Acetal resin, a highly crystalline, linear polymer derived from formaldehyde, was chosen because of its excellent dimensional stability, its low coefficient of friction, its resistance to mineral lubricants such as used in this system, and its excellent fatigue life in oil. Also, tests showed that acetal has outstanding toughness over the service temperature range of —25 to 220 F. An attractive cost advantage also was gained by using acetal, because the parts could be molded to finished dimensions, without machining, on a high volume production basis.

The pump piston *(D)* is an injection molding of ABS resin (acrylonitrile - butadiene - styrene). This high impact plastic is easily molded, is impervious to mineral oil, and has a low specific gravity.

The upper and lower piston cups are made of nitrile rubber (NBR) which will perform satisfactorily in oil at 250 F. A 70-durometer rubber was selected for the upper cup *(E)* where the pressure is about 40 psi. This relatively soft rubber is needed to provide a good seal against the walls and to hold the pressure on the down stroke. A harder nitrile rubber, 90 durometer, was used for the lower cup *(F)* where the



Details of lubricator. *Numbers refer to parts described in the text.*

operating pressure ranges between 60 and 90 psi.

The inlet fuel lines from the engine, and the connection lines between the pump and manifold *(G)*, are extruded nylon tubing with a short-time burst rating of 2500 psi.

Other materials used in the pump assembly are:

Pipe plug *(H)*—heat-stabilized nylon.

Threaded sleeve fittings *(J)*—nylon.

Compression spring *(K)*— music wire.

Reservoir

The three main parts of the reservoir assembly—the body *(L)*, cover *(M)*, and filter cap *(N)*—are made of transparent heat-stabilized nylon. The cover is adhesive bonded in place using fluoro-alcohol. The reservoir is secured to the pump at the bottom with an acetal fulcrum pin which also acts as a check valve *(C)*.

The supply lines *(O)* from the reservoir to the pump are extruded polyvinyl chloride which is oil resistant and resists temperatures down to —25 F.

Manifold assembly

Both the manifold *(P)* and the meter holders *(Q)* are nylon moldings. The meter holders are assembled by merely snapping them onto the manifold. A sharp circular flange on the end of the holder provides the sealing lip for the feed lines.

The metering bladders *(R)*, which are the heart of the lubricating system and expand and contract with each pressure signal, are made of nitrile rubber. The rubber is 60 durometer, has excellent resistance to oil, and can withstand temperatures down to —65 F.

The feed lines *(S)* from the manifold to the grease fittings are polyvinyl chloride. Using this material eliminates expensive screw-type fittings.

The fittings *(T)* are made by solvent bonding (with methyl ethyl ketone) the 3/16-in. o.d. feed line inside a 3/16-in. i.d. tube. As the plasticizer leaches out of the polyvinyl chloride fitting, the fitting hardens and provides a tight fit.

1 **Side-by-side comparison** *of new and regular insulation. Since new insulation has much greater efficiency, only half of usual thickness is required.*

Gas and Fiber Insulation Cut Refrigerator Wall Thickness by 50%

$500 FIRST AWARD

Thomas S. Simms, Russell B. Snyder, Arthur Harder, and Barney Nozaki,
Hotpoint Co., Div. of General Electric Co., Chicago

■ A significant increase in the usable volume of refrigerators has been obtained by using a new insulation system consisting of a sealed bag containing glass fibers and a high molecular weight gas.

Since household refrigerators normally use a 3-in. layer of glass fiber insulation they must have a wall at least 3-in. thick. However, the new insulation (called Wonder-Wall) permits a 50% reduction in wall thickness (Fig 1) and increases the usable volume without increasing external dimensions (Fig 2). Thus, a refrigerator formerly rated at 14 cu ft now has an internal volume of 18 cu ft.

How the insulation is made

As shown in Fig 3, the new insulation consists of three important elements: a thin glass fiber mat; a fluorocarbon gas of high molecular weight and low mobility (Freon-12); and a sealed laminated envelope or bag. In making the assembly, three sides of the laminate are sealed to form an open-end envelope into which the glass fiber mat is inserted. After air is evacuated the envelope is charged with Freon-12. The open end of the envelope is then sealed and the assembly leak checked in equipment sensitive enough to detect a leak of about 1 oz in 100 years. Four different size bags are presently being made for each refrigerator assembly.

How materials were chosen

Literally hundreds of combinations of materials were studied before arriving at the present design. These studies showed that the thermal efficiency of a glass fiber mat could be substantially improved by filling and surrounding it with gases other than air. Of all the gases investigated, Freon-12 proved to have the best combination of molecular and thermal properties. This gas is completely compatible with glass fibers which, fortunately, are quite inert.

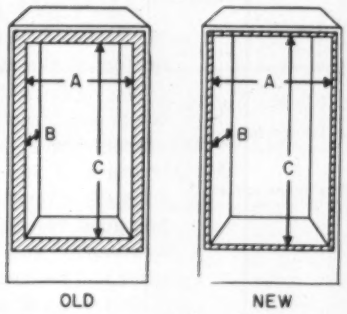
The most important requirements for the envelope material were that it have low permeability and resist Freon-12, oxygen and nitrogen. These requirements were best met by using saran (polyvinylidene chloride copolymer). A double layer of saran is laminated to kraft paper which reduces the effect of microscopic defects in the saran and serves to increase strength and resistance to handling and assembly damage. An outside Mylar polyester film is used over the kraft paper for additional strength and durability and to eliminate water absorption. Also, a special adhesive was developed to prevent delamination in service. The final laminate was the result of years of research and development.

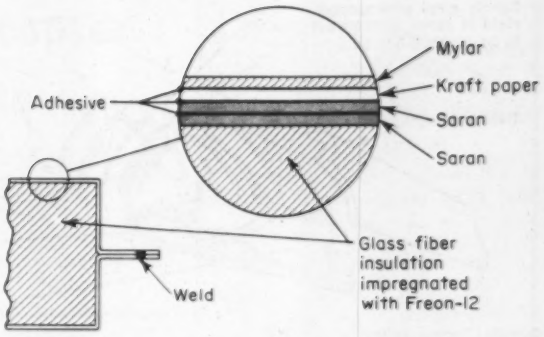
How the insulation performs

As shown in Fig 4, the thermal conductivity (k factor) of the insulation is very low, especially during initial use when little air has permeated into the bag. Conductivity will increase as air permeates into the bag, but even so the insulation's k factor is still much better than that of conventional glass fiber insulations.

2 ***Increase in usable volume****—from 14 to 18 cu ft—is obtained by using new insulation system. Note additional space . . .*

a—side to side
b—front to back
c—top to bottom



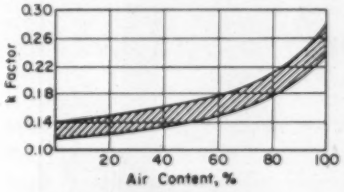


3 ***Cutaway view of insulation.*** *Thermal efficiency of glass fiber insulation is drastically improved by impregnating it with Freon-12 instead of free air.*

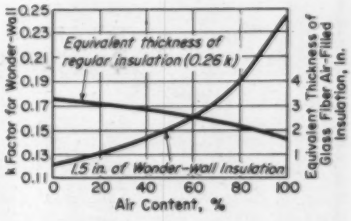
Fig 5 shows the equivalent amount of regular insulation required to equal 1½ in. of Wonder-Wall containing various percentages of air. With 20% air, the conductivity of 1½ in. of Wonder-Wall is equivalent to that of 3 in. of regular glass fiber insulation; even with 40% air, 1½ in. is equivalent to 2¾ in. of regular insulation.

Normally, high percentages of air will not be encountered, as only 2% air is expected to permeate into the insulation every year. However, even this figure is conservative since the rate of permeation is a function of the partial pressure difference; consequently it is continually decreasing. Therefore, even a much higher initial permeation rate than 2% can be tolerated.

It is also worth noting that the data in Fig 4 and 5 were obtained with bags that were hanging free and open to the air on all sides. Actually, when the bags are installed in service between metal surfaces their permeation is greatly reduced. Also, permeation is less at the lower temperatures encountered in refrigerators.



Thermal conductivity range *of envelope insulation with varying amounts of air. High air content is not expected in service, as permeability is less than 2% per year.*



5 ***Equivalent thickness*** *of regular insulation required to equal 1½ in. of new insulation containing various percentages of air.*

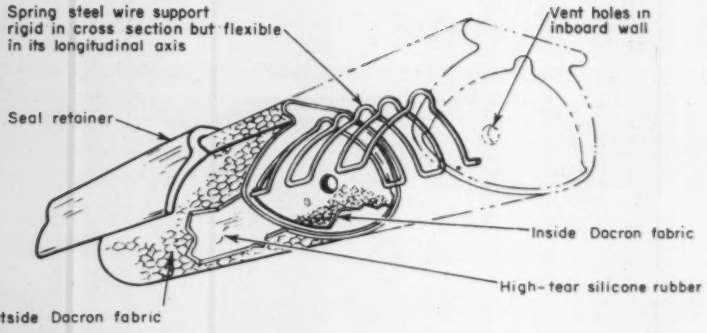
Spring Steel, Dacron Fabric, Silicone Rubber Combine to Make Jet Door Seal 'Fail-Safe'

$100 AWARD OF MERIT

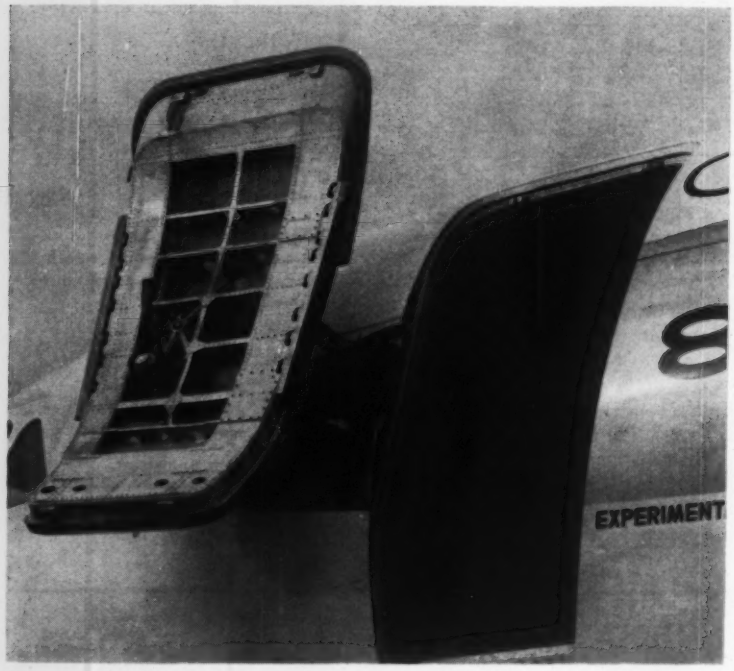
Richard F. Summers, Design Engineer,
Convair, Div. of General Dynamics Corp.,
San Diego, Calif.

■ New fail-safe requirements for today's passenger jets are successfully met in a unique seal composed of 1) a skeleton made of spring steel wire, 2) an inside and outside lining of Dacron fabric, 3) a vented bulb made of high-tear silicone rubber, and 4) a seal retainer.

The seal is designed for entry and service doors on Convair's 880 jet. During flight the flexible spring wire suports the sidewalls of the seal against lateral loads when the differential between



Construction of seal



***Passenger door** in open position showing seal and operating mechanism.*

cabin and atmospheric pressure is highest.

The seal is automatically inflated by the difference in pressure between cabin and atmosphere. A series of small vent holes between the convolutions of the steel wire support on the cabin side of the seal permits cabin air pressure (which is always higher than atmospheric pressure) to enter the seal and push the stretchable Dacron liner firmly against a fuselage striker. The higher the pressure differential the tighter the seal presses against the striker. When pressure differential is equalized, as when the plane is on the ground, the seal deflates; thus, wear that would otherwise result from sliding and wiping action required to open and close the doors is minimized.

Why materials were selected

Silicone rubber, with its good resistance to low temperatures, was selected because it permits the Dacron lining to remain flexible at −75 F, a condition usually encountered in high altitude jets. Another reason: high-tear silicone rubber is strong enough to prevent deterioration from the flexing of the steel wire support.

The high-tear silicone rubber compound meets AMS 3345-A specification; it has a tear strength of 200 ft-lb per in., and a tensile strength of 1500 psi. It has good resistance to ozone and weathering, and fair resistance to acids and solvents.

Spring steel wire was selected as the support for the seal because it can take a great deal of deflection in handling and installation without permanent deformation. In addition, the wire is not affected by the operational temperature of the seal (−100 to 300 F). It processes well on standard equipment, and has no adverse chemical reaction with the silicone rubber.

The cold drawn wire used in the application meets Federal Specification QQ-W-470. The wire, 0.030 in. in dia, has a tensile strength of 330,000 to 465,000 psi.

Dacron fabric was selected because it has better tear and abrasion resistance than any other fabric. The tricot weave of the fabric provides a two-way stretch that permits the lining to expand and compensate for door deflections.

(For information on materials used in other parts of the 880 jet, see M/DE, Apr '59, p 100.)

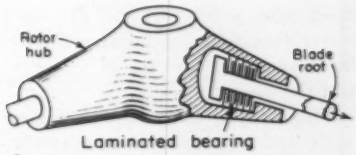
Cost, weight savings

Incorporating the spring steel wire support in the design of the seal resulted in a saving in tooling costs of $40,000. The saving was possible because the seal remains flexible in the longitudinal axis, facilitating installation on corners and highly contoured surfaces without the use of expensive corner molds. Tooling cost on the spring steel wire support was only $1800.

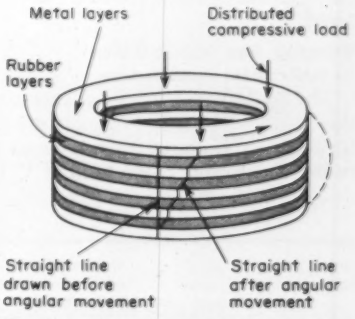
An estimated weight saving of 4 to 6 lb per door was realized with the new seal, compared to other door seals.

Laminated Bearing in Helicopter Reduces Maintenance Costs

$100 AWARD OF MERIT
Randolph Research Co.,
Akron, Ohio



1 ***Bearing*** *supports loads up to 20,000 lb in a helicopter blade root.*



2 ***Simple*** *laminated bearing without lateral support shifts as indicated by dashed line if a large load is applied.*

■ Use of a new laminated bearing instead of roller or ball bearings in the rotor blade roots (see Fig 1) of a small helicopter has greatly improved the operating efficiency of the helicopter and lowered bearing maintenance costs.

Previously used roller or ball bearings had to be replaced often because fretting corrosion (caused by heavy loading and continuous movement around a particular spot) resulted in pitted and damaged parts.

Early test data show the laminated bearing has operated in the rotor blade roots without damage for a million cycles under a load of 15,000 to 20,000 lb. Ultimate life is expected to exceed 15 x 10^6 cycles.

Other advantages: the laminated bearing 1) can withstand very high pressures, 2) has small deflection under load, 3) is low in cost, 4) does not require lubrication, 5) is small and light in weight, 6) is unaffected by dirt, 7) allows no backlash, and 8) has small resistance torque in most applications.

Construction of bearing

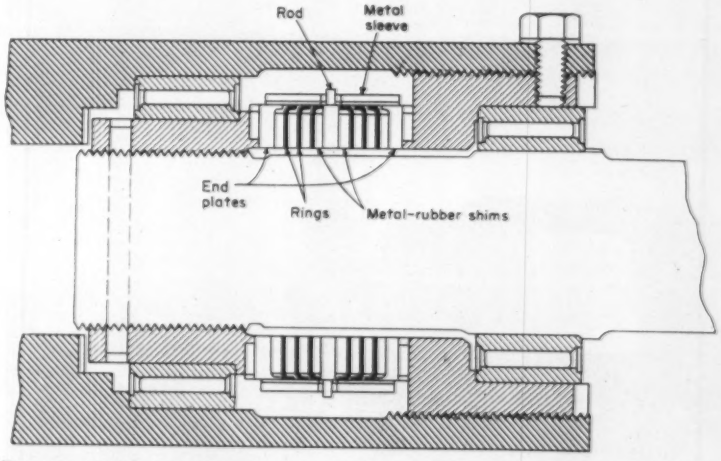
Heart of the laminated bearing is a stack of circular metal shim-like washers separated and bonded together by thin layers of rubber (see Fig 2). The rubber and metal layers are about 0.0013 in. thick.

Because of the thinness of the rubber the shear stress at the metal-rubber interface is not excessive, and loading does not cause the rubber to extrude from between the metal shims. Since the rubber cannot be extruded, the axial deflection of the bearing under load is very small (0.009 in. at a loading of 20,000 lb).

Because the laminated bearing absorbs a load over its entire area, rather than in a small area as with roller bearings, stresses are greatly reduced and sharing the load between several bearings is unnecessary.

Although this bearing in itself is suitable for a number of low load applications, it is not suitable for helicopter rotor blade roots since a large load would cause it to shift laterally (as shown by the dashed line in Fig 1) until it could no longer support the load.

Consequently this basic design is modified by adding rings similar to a cupped washer (see Fig 3). The rings transfer any sideward forces caused by loading from the laminate sections to a circular metal sleeve on top of the bearing. The metal sleeve is



3 ***Modified*** *high load design is achieved by adding rings similar in design to a cupped washer.*

lined with a reinforced TFE material that permits relative angular movement between the sleeve and the rings.

The circular metal sleeve aligns with, and is supported by, the six metal rings in the bearing and two plates at the side of the bearing. A rod running through the center of the bearing keeps the circular sleeve axially centered.

Bearing has low friction in helicopter application

The torque required to rotate the modified bearing from 0 deg through an angle of 10 deg is 60 in-lb. The torque of 60 in-lb at 10 deg under a load of 20,000 lb corresponds to a coefficient of friction of 0.003 of which a small portion is caused by rubbing of the cupped washers against the TFE-lined sleeve. This value is only half the coefficient of friction for ball bearings.

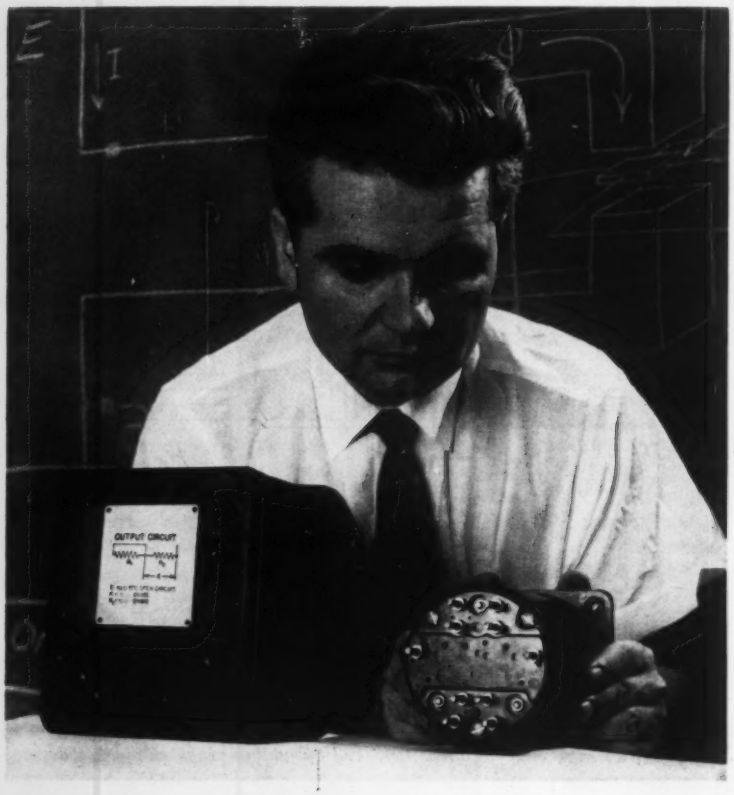
Materials used in bearing

Natural rubber used in the laminated bearing has a low modulus of elasticity, good elongation, a wide temperature range, good resistance to cold flow, and low hysteresis. An oil resistant synthetic rubber could be used in the presence of oil, and a silicone rubber compound could possibly be used under unusual conditions of heat and cold.

Metal used in the shim-like washers is type 301 stainless steel. The stainless steel washers are brass plated to obtain a good bond between rubber and metal. A natural rubber cement is used to bond the rubber strips to the metal washers.

Other parts in the modified bearing, such as lateral support rings, center rod and end plates, are made of stainless steel. The surfaces of these parts are lapped to a fine finish to minimize wear on the reinforced TFE bearing liner.

Better Watt Transducer Design Uses Indium Arsenide Semiconductor



$100 AWARD OF MERIT

Theodore Barabutes,
Newark Meter Div.,
Westinghouse Electric Corp.,
Newark, N. J.

■ The recent development of very-high-mobility semiconductor compounds, such as indium arsenide and indium antimonide, has been put to practical use in the design of a new watt transducer. The new design is much smaller in size and has the principal advantage of providing instantaneous response. Accuracy is better than ½ %.

1 ***New watt transducer*** *(right) is smaller than the conventional type (left) and provides faster response.*

Old design

Watt transducers convert a.c. watts to proportional d.c. millivolts which can operate indicating and recording instruments, servo amplifiers and control devices. The conventional unit is a thermal converter which uses thermocouple elements. Its response is relatively slow—about 1 sec for full scale deflection.

New design

The heart of the new watt transducer design (Fig 1) is the Hall generator—a thin wafer of indium arsenide (Fig 2). The wafer is essentially a solid-state multiplying element which provides an output voltage proportional to the product of the current passing through it and the electrical field perpendicular to it (Fig 3).

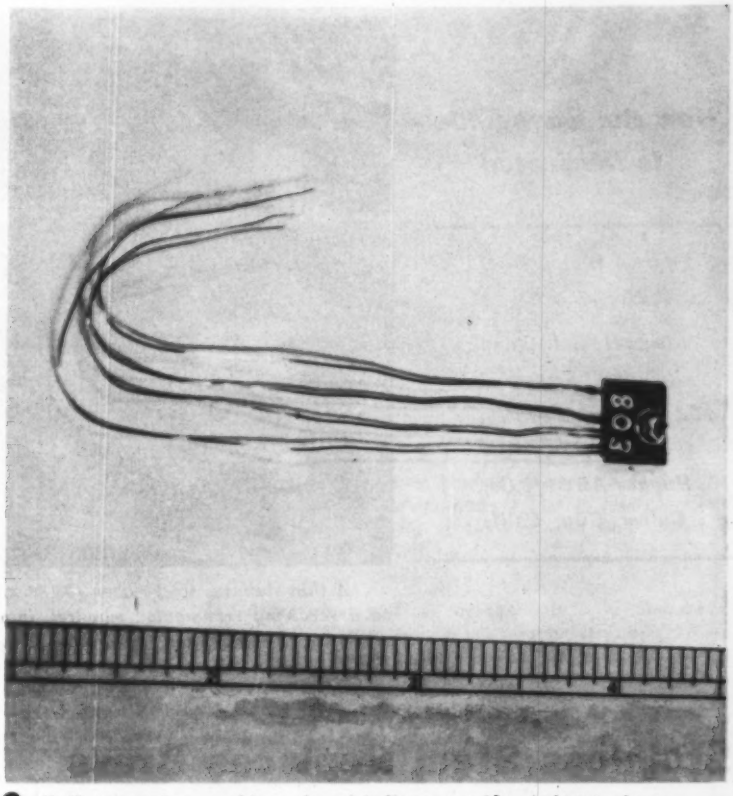
Indium arsenide best

The phenomenon involved is known as the Hall effect, and the output voltage is a function of a term known as the Hall constant. The value of the Hall constant depends upon such factors as the mobility of the semiconductor material and the length-to-width ratio of the wafer. The value also changes with temperature (Fig 4). The minimum rate of change occurring with indium arsenide makes this material superior to indium antimonide for this application.

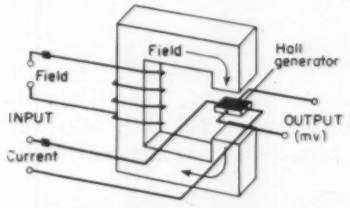
Another advantage of indium arsenide is its relatively small change of resistivity with temperature. Large changes may effect the external circuit.

Uses of the Hall multiplier

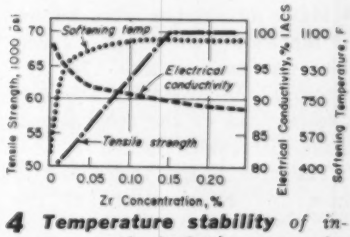
The Hall multiplier is universally applicable to any device requiring an output proportional to the product of two electrical quantities. In 1958 a new type of wattmeter was designed to use the multiplier. In 1959 the device was used as the basis for the design of two types of new watt transducers. One type produces an unfiltered d.c. current in the milliampere range; the other (Fig 5) produces a filtered d.c. millivolt output for devices which require a signal free of ripple.



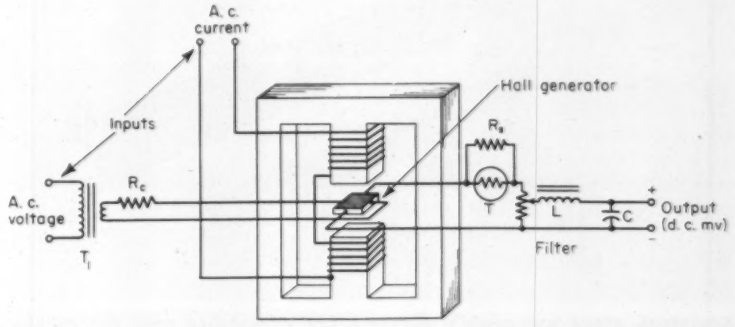
2 Hall generator—*a thin wafer of indium-arsenide—is heart of new transducer design.*



3 Hall multiplier *is a Hall generator placed in a magnetic field and supplied with current to produce an output voltage proportional to the product of the inputs.*



4 Temperature stability *of indium arsenide is basic reason for selecting this material instead of indium antimonide.*



5 One type *of new watt transducer. It produces a filtered d.c. millivolt output.*

How the waveguide is fabricated →

$100 AWARD OF MERIT

James H. Holley and Robert Y. Scrapple, Materials and Processes Section, Hughes Aircraft Co., Culver City, Calif.

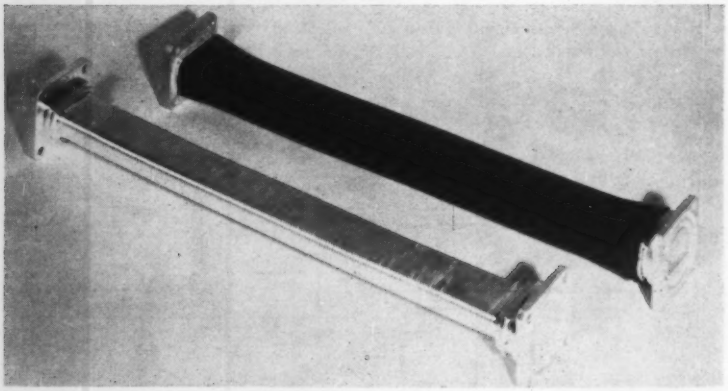
A thin stainless steel ribbon (0.186 x 0.003 in.) is spirally wound and formed, on a revolving rectangular mandrel, into tubing with an interlocked convoluted structure. Brazing alloy (silver plus lithium) is simultaneously fed into the interlock.

Stainless Steel Replaces Brass In Stronger, Cheaper Flexible Waveguide

■ Many advantages were gained by fabricating semi-rigid, or flexible, waveguides from 17-7 PH precipitation-hardenable stainless steel instead of the conventional brass with rubber jacket.

The new design was found to meet the requirements of the Hughes Aircraft Co. product specification for semi-rigid (flexible) waveguides. This specification includes tests for such electrical characteristics as attenuation and power-handling capacity; such mechanical tests as bend, extension and vibration; and such environmental tests as salt spray, humidity exposure, and soaking in hydraulic fluids at elevated temperatures.

As a result, it is expected that the stainless steel waveguide will not only replace older types of conventional semi-rigid waveguides, but may also supersede rigid waveguides in certain applications.



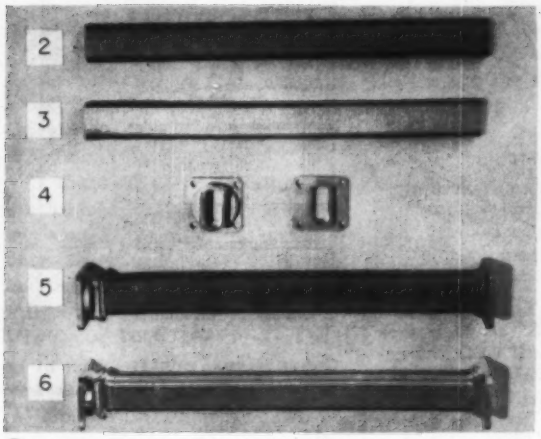
Stainless steel waveguide *(bottom) has advantages over the rubber-jacketed brass waveguide (top) at every step, including design, production and end-service.*

Ten advantages gained

The advantages of the new design may be summarized as follows:

1. Mechanical strength is greatly increased. Tensile strength and endurance limit are about four times those of the conventional waveguide.

2. The stainless steel waveguide does not require rubber jacketing for protection against mechanical damage, for vibration damping, or to maintain its shape under pressure. Resonant frequency in vibration is two to four times higher



2 *Tubing feeds off the mandrel as a continuous rectangular tube which can be cut to the desired length.*

3 *After being cleaned and dried, tubing is brazed in a dry hydrogen atmosphere electric furnace at 1825 F to produce a pressure-tight joint. This treatment also serves as the first of three heat treatments for the 17-7 PH alloy.*

4 *Flanges for the tube ends may be a copper-base alloy or, when weight is critical, an aluminum alloy that has been electroless nickel plated.*

5 *Torch or induction brazing is used to join copper alloy flanges; high temperature solder to join aluminum flanges. The assembly is then cleaned and etched in preparation for plating.*

6 *After silver plating, the assembly is refrigerated 8 hr at –100 F to attain a martensitic structure. Final treatment is precipitation hardening 1 hr at 950 F.*

7 *Forming to the desired shape is accomplished by hand bending around a die. Bends can be made in either or both planes of the rectangular cross section.*

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than that of the brass, and resonant amplitude only one-fourth to one-eighth as great.

3. The new material has greater design flexibility. For example, minimum bending radius is now 1 in. instead of 3 in. when the bending line is across the greatest width of the rectangular cross section; 3 in. instead of 6 in. when the bending line is across the narrowest width.

4. Longer waveguides are now feasible with the elimination of the molded rubber jacket. A 12-ft guide has been fabricated with no more difficulty than the normal 1 or 2-ft lengths.

5. A 7% lower overall cost has resulted. Although the basic materials cost of 17-7 PH stainless steel is higher than that of brass, two side results actually lower the total cost. One is the elimination of the cost of molding on the rubber jacket. The second is the elimination of subsequent cleaning and electrical testing operations which the molding step necessitated.

6. A weight saving of 40% is realized. This figure is based on the use of conventional copper-base alloy flanges at the ends of the stainless steel waveguide. Where minimum weight requirements dictate the use of aluminum flanges, total saving is 70%.

7. High temperature service limit is 1000 F where brass flanges are used (600 F with aluminum flanges), as opposed to 250 F for the conventional waveguide.

8. The convolution brazing process used provides pressure-tight joints with high consistency and has reduced the rejection rate experienced with brass waveguides, thus further reducing the costs of production and testing.

9. Corrosion resistance and electroplating quality are higher because the assembly is brazed; the brass waveguide was soldered with flux which could become entrapped in the joint.

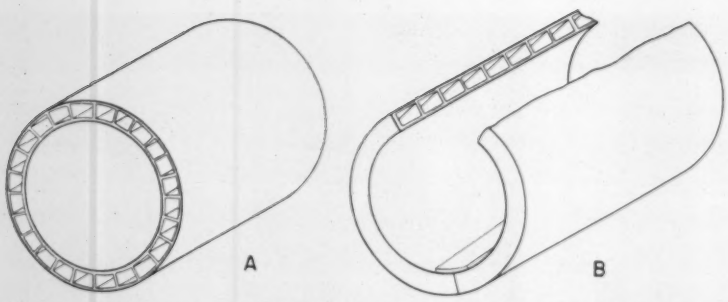
10. The same machines and tooling previously used can be used to form the conventional brass waveguide.

Why 17-7 PH stainless?

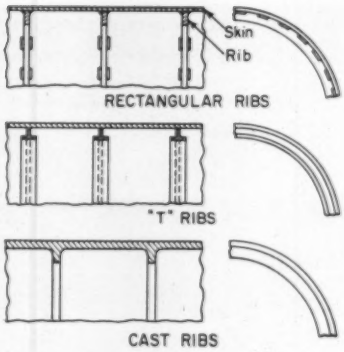
The 17-7 PH alloy was selected because of its high strength properties at both room and elevated temperatures and because of the ease of fabricating the material in the annealed condition. An added advantage: brazing of the transmission tubing could be accomplished during the initial heat treatment of the steel.

The tensile strength of the alloy in the heat treated condition (200,000 psi at room temperature), together with its inherent damping characteristics, enabled designers to dispense with the operation of molding on a ¼-in. rubber jacket.

The award winners wish to acknowledge the initial work of J. I. Stillman in this program.



Two new designs *use extruded cell and rib instruction.* ***Left****—Axial cell voids characterize one new design. Extruded aluminum "C" shape is first flattened and then rolled into cylinder.* ***Right****—peripheral cell voids characterize second new design. At 2000-ft depth this design provides 11% weight saving over conventional design.*



Conventional construction *of externally pressurized vessels obtains strength from rectangular ribs, "T" ribs or cast ribs.*

Aluminum Extrusions Raise Design Efficiency of Externally Pressurized Vessels

$100 AWARD OF MERIT

Thomas P. M. Rouse, Jr., Project Engineer,
U. S. Naval Underwater Ordnance Station,
Newport, R. I.

■ Cylindrical aluminum 6061-T6 extrusions can now be used to form a rigid box-like structure to serve as the wall of vessels to be used underwater. The new design uses a minimum amount of materials and has the following advantages over conventional designs: weight savings of 11% and higher, maximum resistance to buckling, greater volumetric efficiency, fewer fabrication steps, and built-in tankage.

Old designs

Previous methods (see drawings) made use of steel or aluminum ribs which, because of the large radial depth required by the need for a high moment of inertia, reduced volumetric efficiency and used more materials. The high moment of inertia was required to resist high curved-column buckling loads imposed by the relatively wide spacing of the ribs.

New design

The new design uses a C-shaped aluminum extrusion (for convenience of die size) which is then flattened and rolled into a cylinder. As the drawings show, axis of the cylinder may be at right angles to the direction of extrusion (A) or parallel to it (B).

In *A* the edges are machined, the ribs notched, and the structure welded with an insert to form a keel which will make it possible to weld the ribs. The notch in each rib enables access to each peripheral cell formed.

In *B* joining rings are welded to each end of the cylindrical extrusion; a groove machined in one of the rings enables access to each of the axial cells.

ADVANTAGES OF NEW DESIGN

Design Type[a] →	2000-Ft Depth			5000-Ft Depth		
	Conventional	A	B	Conventional	A	B
Internal Volumetric Efficiency, %	75.4	80.6	77.7	54	69.5	68
Total Volumetric Efficiency, %	—	91.7	90.6	—	86	85.9
Material Weight, lb[b]	110.9	86.6	98.8	5.17	3.84	4.74
Weight Savings, %[c]	—	22	11	—	108	68
Coefficient of Buoyancy[d]	0.70	0.78	0.75	0.51	0.73	0.55

[a] See drawings.
[b] Calculated for 37-in. length at 2000 ft; 1-in. length at 5000 ft. Both 19-in. o.d.
[c] Compared to the lowest weight conventional design.
[d] Coefficient of buoyancy = 1 — (weight of structure/weight of displaced water).

In both designs the cells not only provide a rigid structure to resist buckling but can also be used for storage of fuel, lubricant or oxidizer; for ballast; for acoustic attenuating material; or as cable conduits.

If shapes other than cylindrical are desired, they can be achieved by stretch forming the original flattened extruded slab. High volumetric efficiency and optimum utilization of material would still result, but the additional steps would raise the cost considerably.

New vs old

Volumetric efficiencies and weight of the new designs can be readily determined by calculations that will not be given here. Essentially the dimensions of the aluminum extrusions are determined from the required moment of inertia. The volumes of the entire materials structure, the inner space and the cell spaces can then be calculated. From these volumes, the following efficiencies can be computed:

Internal volumetric efficiency equals total volume within i.d. divided by total volume within o.d.

Total volumetric efficiency equals total volume within i.d. plus volume of cell voids, the sum divided by total volume within o.d.

An example—Typical values for design *A* assuming a 19-in. o.d. vessel at 2000-ft depth under sea water are:

Int vol effic = 80.6%

Total vol effic = 91.7% (cell voids are 11.1%)

These efficiencies, as well as the coefficients of bouyancy, are considerably higher than attained by conventional designs (see Table).

From the volume of material used and the density, the weight savings in the new design can be calculated. The basis of comparison used below is a 37-in. long torpedo afterbody.

	Weight, lb
Aluminum rectangular ribs	136.9
Aluminum "T" ribs	110.9
Steel cast ribs	118.1
New design *A*	86.6

Thus the new design can provide a weight saving of (110.92-86.6)/110.92, or 22% compared to the lowest weight conventional design at 2000-ft depth.

The accompanying table summarizes the weight and volumetric advantages of the two new designs for two applications.

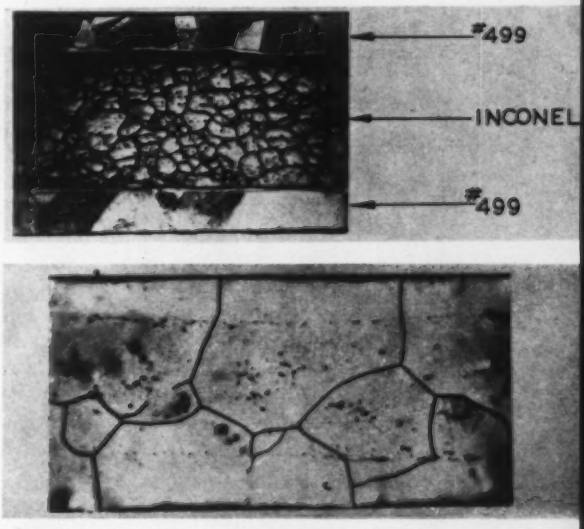
Composite Cathode Metal Improves Tube Operation, Simplifies Circuits.

$100 AWARD OF MERIT

W. T. Millis, J. F. Stephens, and J. G. Tucker,

Receiving Tube Dept.,

General Electric Co., Owensboro, Ky.



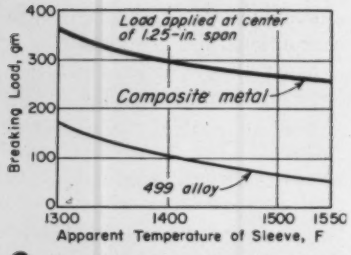
1 ***Nickel alloy sandwich*** *0.0025 in. thick (1300X).* ***Top****—As received, showing three layers.* ***Above****—After 10,000 hr operation, showing single structure, yet layers still clearly distinguishable.*

■ The new nickel sandwich material shown above combines the good thermionic emission characteristics of a high nickel cathode alloy with the high hot strength of Inconel. The result is substantial improvement in "bowing" resistance of oxide-coated cathodes for thermionic tubes. Also, microphonics are reduced.

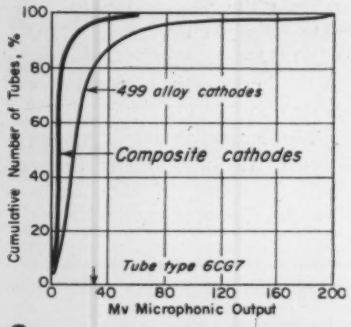
The bowing problem

Thermionic tubes, such as receiving tubes used in aircraft, marine and railroad equipment, are often subject to shock loading or vibration, which can result in buckling or bowing of the cathode. Such bowing alters the spacing between cathode and surrounding tube elements, thus changing the behavior of the tube, and in some cases causing inter-element short circuits.

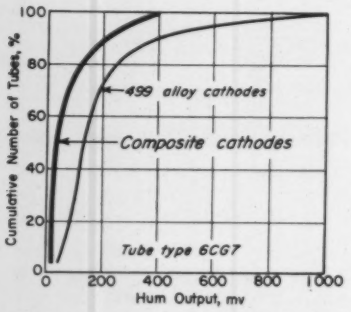
To minimize this bowing, tubes for such equipment have generally been limited to those with short cathodes, or cathodes with small length-diameter ratios. Although special alloys have been developed to improve hot strength of cath-



2 ***Improved hot strength*** *of clad composite metal is obvious here.*



3 ***Microphonic output*** *of type 6CG7 tube is substantially reduced by composite base metal.*



4 ***Hum*** *can be substantially reduced in certain types of tubes.*

odes, thermionic emission characteristics have suffered.

Clad cathode is solution

After extensive development, General Electric solved the problem by cladding Inconel on both sides with Driver Harris's 499 nickel cathode alloy. The combination provides the passive emissive properties of the high nickel alloy, yet is independent of the relatively poor thermionic properties of the core material which provides high hot strength. Such a beefed up base metal for oxide-coated cathodes permits use of longer cathodes in receiving tubes, resulting in substantial increases in 1) current capability, 2) power output, and 3) anode area and plate dissipation capability. To a circuit designer these factors mean fewer tubes and circuits for a given set of performance requirements.

Other benefits of the composite material include reduced microphonics (vibration-induced noise), and lower thermal expansion and thermal conduction.

Tests on EIA (Electronic Industries Assn.) 6080WA and 807 tubes have shown that cathodes made of the composite material withstand shock loads three times as severe as those normally required to bow conventional cathodes.

Hot strength comparison

The photomicrographs in Fig 1 show the structure of the clad strips, both as-received and after 10,000 hr of tube life. After use the structure becomes that of one metal, but the three layers do not entirely lose their identity. Thermionic emission characteristics measured after extended service indicate that the chemical composition of the surface alloy has not altered substantially.

Fig 2 shows the substantial improvements in hot strength obtained in the composite material. Data were obtained from bending tests on type 807 tube cathode sleeves.

Improvements in strength were shown more practically by actual shock tests in a Navy type high impact (flyweight) shock machine. Shock loads of 450 G (30-deg hammer angle) caused serious bowing of the 499 alloy cathode. The composite cathode showed no bowing at shock loadings up to 750 G (50-deg hammer angle)—the highest load tested.

In tests on cathodes of smaller length-diameter ratios (type 6080 tube), the composite cathode exhibited no bowing under loadings of 450 G at elevated temperatures (9.0 v E_t) and loads of 900 G at normal temperatures.

Other benefits

In addition to resistance to bowing, the composite material offers:

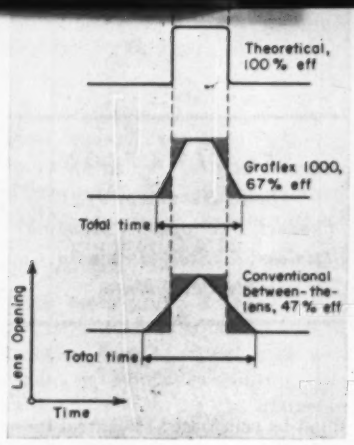
1. Lower thermal expansion—Low thermal expansion characteristics are desirable in cathode materials because of the range of temperatures over which cathodes are processed and used. Expansivity of the clad cathode material is slightly lower than that of the 499 nickel alloy, amounting to dimensional changes of only 0.002 to 0.016 in. per in. over a temperature change of 200 to 1800 F.

2. Lower thermal conductivity—The composite material has a lower thermal conductivity than the 499 alloy, reducing cathode heat loss through cathode connectors and supports.

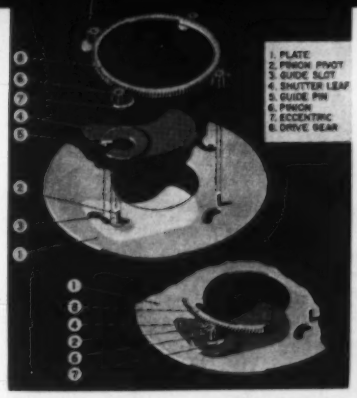
3. Equal electrical characteristics—Electrical characteristics of the composite material are essentially the same as those of the 499 alloy. The similarity has been shown by extended life tests on several types of tubes. Transconductance, anode current, interface resistance and grid emission were considered to be descriptive of the thermionic properties. Differences found in transconductance and current stability were not significant.

4. Less microphonics—The new base metal also improves microphonics in tubes such as the 6CG7. Fig 3 shows the lot distribution of microphonic output on two lots of tubes, one with the 499 alloy cathode, the other with the composite base metal. In this case, the higher microphonic output of the 499 cathode tubes was due to the softness of the alloy which permitted mica spacers to form indentations, resulting in loose fittings.

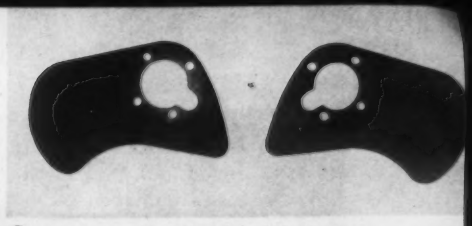
5. Lower hum output—Fig 4 shows the improvement in hum output obtained by the composite material in a 6CG7 tube; similar improvements were obtained in a 6072 tube. The improvements were due to tube processing techniques permissible with the stronger cathode metal.



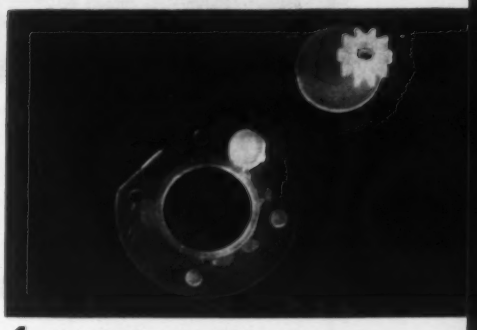
1 **Comparison** *of theoretical, new, and conventional shutter efficiencies at speed of 1/500 sec. Efficiency is based on the relationship between effective time (the ASA procedure which rates between-the-lens shutters on the basis of light admitted) and total time (time from beginning of opening to end of closing).*



2 **Detail of Graflex 1000 shutter** *shows new operation concept. Each of four shutter leaves is separately mounted and guided by an eccentric and a stud operating in a slot. The resulting elliptical blade motion eliminates abrupt stops and reverses, and allows the shutter mechanism to accelerate at top speed before the blades open. The blades close with a gentle breaking action, thereby minimizing shutter vibration, shock and bounce.*



3 **Nylon hub** *(left) is fastened to magnesium blade simply by melting over rivet ends (right).*



4 **Detail of nylon hub** *and combination pinion and eccentric.*

Nylon, Magnesium Speed Up Camera Shutter

$50 CITATION

Archie H. Gorey, Senior Development Engineer, Graflex, Inc., Rochester, N. Y.

■ Careful materials selection, particularly the use of lightweight nylon and magnesium, has enabled engineers to achieve maximum efficiency from a new Graflex 1000 between-the-lens shutter design. The new shutter, claimed to be the fastest and most accurate of its type yet developed, permits exposures up to 1/1000 of a second with complete uniformity of exposure and without the limitations normally associated with focal plane shutters (see Fig 1).

Previous materials inadequate

The redesigned shutter (Fig 2) is the result of ten years of research and development. In early designs the pinions were made of steel, the leaf hub carrying the guide pin was aluminum, and the guide pin was hardened steel. Rivets were used to fasten the parts together. This assembly produced an exceptionally fast and efficient shutter (1.4 to 1.5 millisec effective time and 2.2 to 2.4 millisec total time) but it had several drawbacks.

First, the machining and assembly of parts was too expensive, especially since four units were required for each shutter.

Second, the weight of the components was a handicap in obtaining even higher speeds.

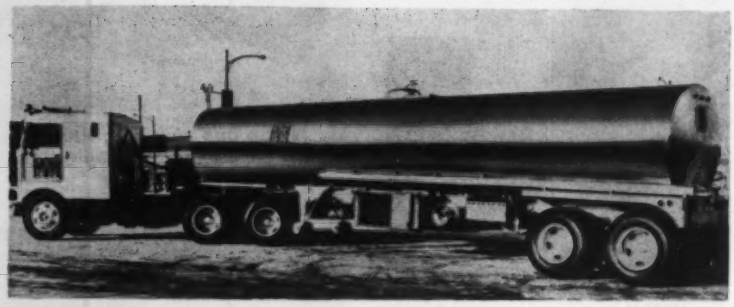
The third and greatest drawback of all was that no hardened guide pin would stand up for more than 1000 cycles.

Materials substitution saved new design

Because of the above materials problems the shutter design seemed doomed. Fortunately, however, the design proved feasible when it was learned that both the leaf hub and the eccentric pinion (80 pitch) could be made as nylon moldings. The molded leaf hub was designed to include the guide pin and rivets which are simply melted over to attach the hub to the leaf (Fig 3 and 4).

The change to nylon resulted in several important advantages. Not only did the nylon pin last longer (one has yet to wear out) but the plastics parts cost 10% less to make than equivalent metal parts. Also, because of nylon's lower weight and friction the speed of the shutter was reduced to 1.2-1.3 millisec effective time and 2.0-2.1 millisec total time.

Still greater speeds were obtained by changing the shutter leaf to magnesium. Magnesium sheet is rolled to a thickness of 3.5 mils and cut to shape after an accurate straightening operation. The magnesium blade leaves are given a chromate conversion treatment and finally coated with molybdenum disulfide to reduce friction. By using magnesium the effective shutter time was reduced to 0.9-1.0 millisec and total time to 1.6-1.8 millisec.

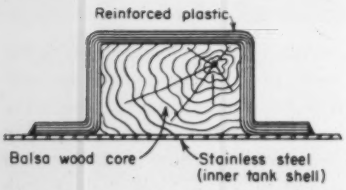


Thin-wall metal tank *for trailer poses design problems solved by reinforced plastic.*

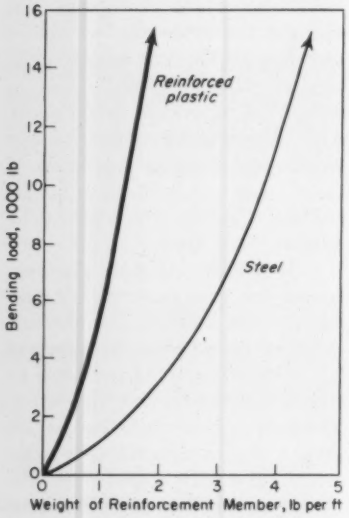
$50 CITATION

L. J. Hessburg, Jr., Product Development Manager, Stainless & Steel Products Co., St. Paul, Minn.

Glass-Epoxy Reinforcing Rings Cut Weight of Trailer Tanks



Reinforcement member *design allows molding channel in place over balsa wood core between inner and outer shells.*



Bending tests *indicate weight savings possible when replacing steel reinforcement rings with reinforced plastics.*

■ Glass-reinforced plastics have been fabricated in place to serve as structural reinforcing rings for the tanks of large transportation trailers. Savings in labor over the welded steel rings range from 30 to 50%; savings in weight run as high as 750 lb on a large trailer.

The design problem

Designers have consistently been forced to reduce the metal gages used for the tanks of these trailers to meet legal weight requirements. As a result stress cracking is a common occurrence, particularly in the sanitary or clean-bore tanks where internal support is prohibited. A common method of reinforcement has been to use steel encircling rings of channel or hat-section shape.

Tanks of this type, such as might be used to transport milk, are actually thin-walled shells. When loaded and subject to impact and bounce, they behave like a long balloon filled with water and supported on the ends. The top center and the bottom sections over the supports tend to deflect inward and the entire cross section to flatten out. If the deflections cause stresses that exceed the elastic limit of the metal, permanent buckling occurs. The shell must be reinforced to control these deflections.

The old method: steel rings

Common reinforcements are ribs that encircle the girth of the tank. They may range from 2 x 1-in. bar stock channel slipped over the inner shell of a small truck tank to 4 x 2-in. rings welded solidly to a large tank shell. A large tank may contain between 500 and 1000 lb of such reinforcement. The welding, grinding and polishing time required is often a significant cost factor.

The new method: reinforced plastics

The new material is a preimpregnated, preoriented glass-epoxy material (Scotchply Type 1002, produced by Minnesota Mining & Mfg. Co.). With this material it is easy to tailor the size, shape and thickness of the supports to fit individual problems. A vacuum bag forming technique is used with essentially no mold cost. The plastic is formed around a balsa wood core which was chosen for its light weight and ability to withstand the curing temperature.

Essential properties that led to the selection of the particular reinforced plastic include: almost perfect elasticity up to high ultimate strength, excellent fatigue strength, high flexibility, and directional properties. These properties make it possible to not only withstand high stress but also distribute them so that stress concentrations were eliminated.

Bending tests (see graph) indicated that the new reinforcement material would give comparable or better strength at a fraction of the reinforcement weight. Shear strength of the bonds was

good enough to permit flexing to reasonable design stresses. Though material costs are higher, savings in labor cost are great enough to provide a total cost reduction.

Tank tests prove design

The new tanks stand up well in tests so far. A service test was made by slowly evacuating the tank and measuring the diameter changes until buckling occurred. First the tank was subjected to this test while reinforced with steel bands. It was then returned to its original shape and the plastics rings substituted. When the vacuum test was repeated, the tank withstood a pressure differential substantially higher than before without signs of buckling, despite the fact that the area of original buckling was more vulnerable.

In this test the plastic rings withstood the high bending loads as expected from the laboratory tests. There was no evidence of adhesive failure. Although tensile and shear stresses on the bond are not high, the depressions of the tank shell between rings tend to create a stress that might peel the shell away from the rings. However, the flexibility of the plastics flanges allows them to give with the shell, thereby reducing peel stresses.

Similar experiments conducted with steel rings that were epoxy-adhesive bonded to the shell showed that the epoxies were unable to withstand the stress concentrations set up by the rigid steel flanges.

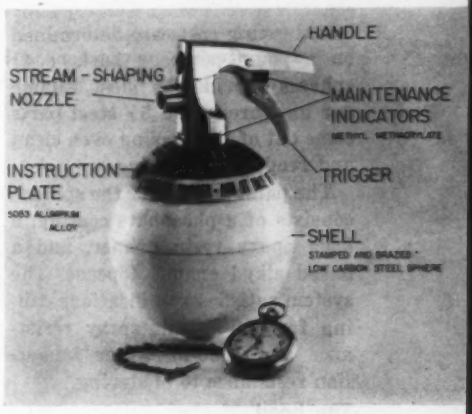
Future tank applications

When tanks reinforced with the new materials have been road tested, other applications will be considered. The largest potential weight saving remaining in the sanitary tank is the chassis frame and bolster assemblies. The high strength-weight ratios possible with directionally-reinforced plastics, plus their flexibility in processing and their excellent fatigue strength and corrosion resistance, suggest their use in such applications.

Steel, Aluminum Combined in Improved Fire Extinguisher

$50 CITATION

Development and Design Div., Ansul Chemical Co., Marinette, Wis.



***Compact fire extinguisher** features a disposable, rechargeable shell.*

■ Low carbon steel, die cast aluminum and stainless steel have been combined in a new dry chemical fire extinguisher that is said to overcome many of the disadvantages associated with previous extinguishers. The new unit is low cost, lightweight, compact, simple to operate, easy to recharge, reliable without maintenance inspection, and eight times more effective than the conventional 1-qt pump gun extinguishers.

The small, rechargeable extinguisher consists essentially of three major components: 1) a sealed, disposable shell containing the dry chemical and expellent gas; 2) a control head consisting of handle, body, stream-shaping nozzle, and combined trigger-operated puncturing pin and shut-off valve; and 3) a spring-grip mounting bracket.

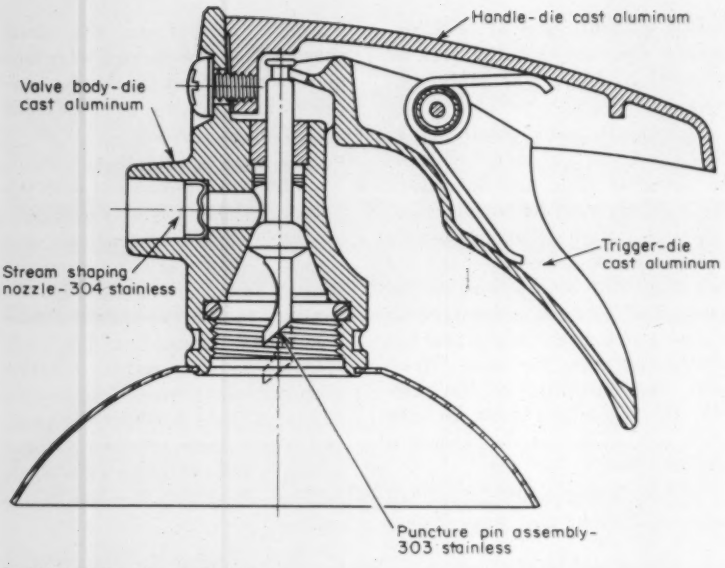
The shell

Specifications for the shell called for it to have an internal volume of 80 cu in., hold a charging pressure of 190 psi, withstand an air leak pressure test of 570 psi, withstand a minimum rupture pressure of 1140 psi, satisfy Coast Guard requirements for corrosion resistance, and withstand temperature variations from —40 to 120 F.

Four materials were considered: steel, aluminum, brass and plastics. Stamped hemispheres, deep drawn cylinder halves, tubing with end caps and canteen-shaped stampings were investigated for all three metals. Aluminum impact extrusions and brass spinnings were also considered. Overall costs for all of the above were divided into four categories: raw material, forming, joining and finishing.

Plastics were ruled out immediately because none could meet specifications without costly reinforcement and gastight linings.

After careful cost analysis, a low carbon steel sphere, furnace brazed with copper, was selected for the shell. Here's why: 1) steel hemispheres can be stamped in one draw and therefore do not require annealing operations; 2) steel sheet is inexpensive; 3) because least weight is achieved with a sphere, brazing costs are



Detail of head mechanism

low (brazing costs are determined on a pound-per-hour basis); 4) spheres provide the most volume per unit area; and 5) steel parts come out of the brazing oven clean and ready for finishing.

The paint system for the spheres consists of a phosphate coating, a flash epoxy resin primer, and a baked alkyd enamel topcoat. The system satisfies specifications calling for 500-hr salt spray resistance and 1000-hr water immersion resistance to blistering.

The head

Die cast aluminum was selected for the handle, trigger and body in preference to brass or zinc forgings, stampings or screw machine parts; or plastics moldings. Although cost was the determining factor an aluminum alloy 360 die casting with a chemical conversion coating also provided a good combination of light weight, strength and corrosion resistance.

Type 303 stainless was selected for the puncture pin because it had to resist "freezing," or sticking, due to corrosion, and had to have a minimum hardness of Rockwell C25 to keep its milled tip sharp for puncturing the seal disk on the shell. Type 304 stainless was selected for the stream-shaping nozzle.

The bracket

To provide strength at low cost, low carbon steel wire parts were selected for the attachment bracket. To prevent abrasion of the shell, the bracket parts that come in contact with the shell are given a vinyl dip coating. The rest of the bracket is zinc plated.

The upper arm of the bracket acts as a safety lock to prevent movement of the trigger. It remains on the bracket when the extinguisher is removed, freeing the extinguisher for instant use.

Other materials used

A neoprene o-ring was selected to seal the shell to the head because it offers both weather and abrasion resistance. Neoprene is also used as a valve member at the tip of the puncture pin.

A 303 stainless steel insert acts as a guide for the puncture pin. The bottom of the guide is protected from the dry chemical by an impregnated felt-nitrile rubber laminate.

Two red plastics indicators, one on the handle and one on the body, are designed to pop off if either the trigger is moved or the shell is unscrewed. Methyl methacrylate was chosen for the indicators because it was found to have the necessary combination of springiness (to prevent false operation) and notch sensitivity (to snap off when necessary).

Finally, an etched aluminum alloy 5053 plate carries operating and maintenance instructions.

Redesigned Memory Stack Is Smaller, More Reliable

$50 CITATION

General Ceramics Div., Indiana General Corp. Keasbey, N. J.

■ Redesign of a ferrite memory stack accomplished three objectives: reduction in size, dependable performance in a broader temperature range, and improved reliability.

Stack requirements

The memory stack consists essentially of 2048 ferrite cores strung on wires and folded to form a cube of cores.

The projected environmental temperature range for the memory stack was −67 to +176 F. In order to meet the requirement that the core operate at a fixed internal temperature, within ±9 °F, the designers decided to heat the entire unit to 185 F and maintain it at that temperature.

The heater had to be rigid enough to maintain the cubical formation of the cores during as-

sembly but flexible enough to avoid applying pressure to the ferrite cores. Ferrite cores are sensitive to pressure effects and are quite brittle. A chip or crack in the core destroys its usefulness; excessive pressure on the core periphery while it is in operation will change the magnetic characteristics of the core.

How temperature control was achieved

The heater pad was made of resistance wire sandwiched between 0.004-in. aluminum foil and a thin sheet of silicone-impregnated fiberglass. Such design had four principal advantages:

1. When folded to form a cube, the heater met the rigidity requirements.
2. The insulating qualities of the fiberglass layer resulted in uniform warming of the aluminum foil and even heat distribution over the ferrite stack.
3. Use of readily available materials and simple design made the heater relatively inexpensive.
4. All of the 96 wires of the memory stack easily passed through the top and bottom folds of the heater pad.

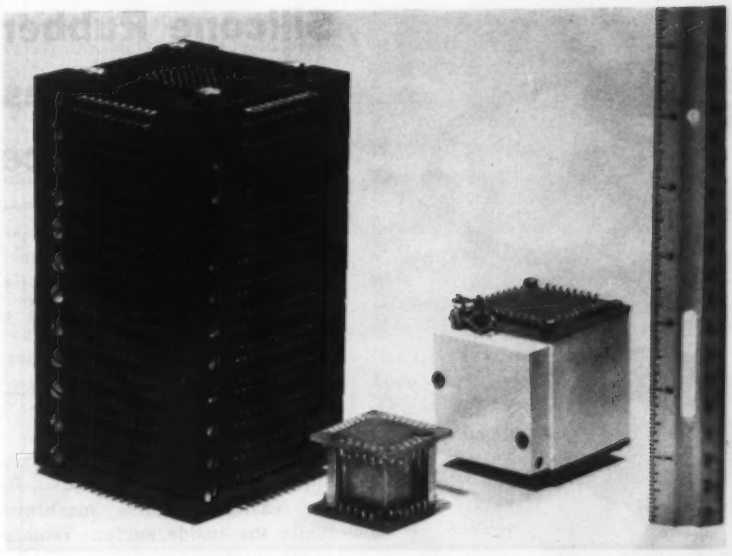
Foamed urethane rubber (thermal conductivity: 0.025 Btu/hr/sq ft/°F/ft) was used as an insulator. This material can be compressed to 80% of its original thickness, will not apply excessive pressure on the core, and retains its compressive properties over the range −76 to 390 F. In addition, it can be foamed in place or cut to shape from commercially available sheet.

As a result of this construction, there is only a 3.5 °F difference in temperature (as measured by thermocouple) between the approximate center of the stack and any outside surface. At an ambient temperature of −67 F, an input of approximately 6 w maintains internal temperature at 185 F.

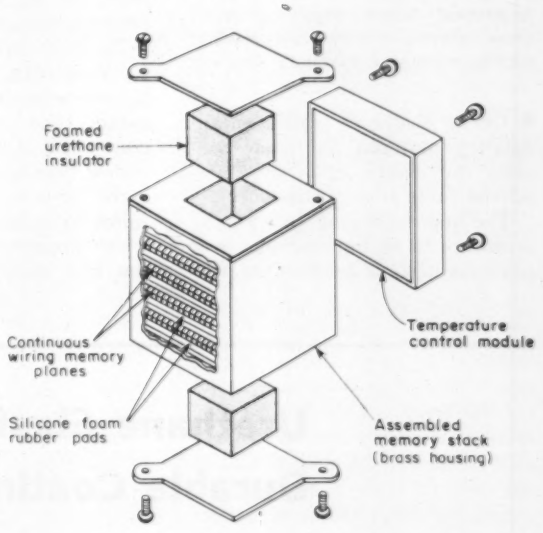
Reliability and size

Instead of conventional memory planes, the designers used continuous wiring memory planes separated from each other by 0.046-in. thick pads of silicone foam rubber. With the elimination of the rows of solder connections around the periphery of conventional memory planes, the number of solder connections was reduced from 1450 to 92—a significant contribution to reliability.

As a consequence, the bulky plastic frame ordinarily used to hold the wiring and cores of conventional memory planes was eliminated. Volume of the memory stack was reduced from 70 cu in. to 12.5 cu in. Without the temperature control circuit the new volume is only 3 cu in. (see photo).



***Comparison** of old and new memory stacks. **Left**—Conventional stack of 12 16x16 planes. Volume—70 cu in.; density—75,000 memory bits per cu ft; solder connections—1450. **Center**—Microstack provides same storage capacity in 3 cu in. (23:1 size reduction). Core density—1,500,000 per cu ft; solder connections—92. **Right**—Microstack with temperature control circuit and insulation has volume of 12.5 cu in. (5.5:1 size reduction). Core density—375,000 per cu ft.*



Exploded view of stack components

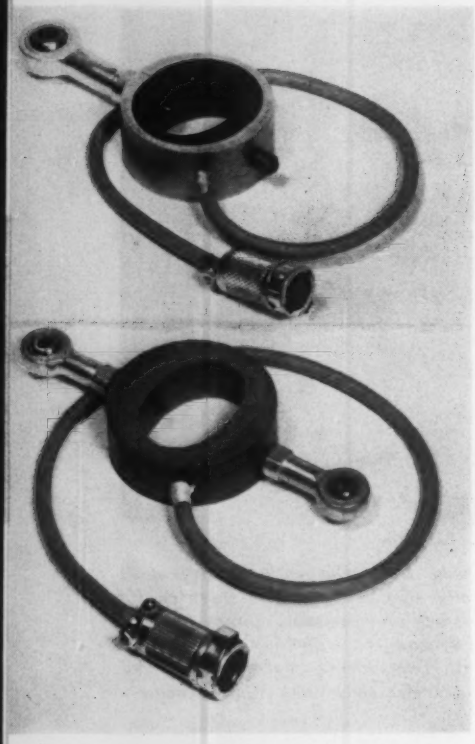
Silicone Rubber Potting Material Makes Possible Improved Force Ring

$50 CITATION

Laboratory Instrumentation (Depts. 47-45 and 47-40)

AiResearch Mfg. Co. of Arizona,

Div. of Garrett Corp., Phoenix, Ariz.



***Improved force rings** use color-coded silicone rubber to encapsulate strain gages and wiring.*

■ Use of a silicone rubber encapsulating material has made possible the design of a new, improved force ring (transducer).

The new force ring (see photo) is said to be an improvement over previous designs because the outside surface remains circular for the easiest possible machining while the inside surface remains eliptical. The tapered wall thickness places more surface at the fittings, giving the ring a "unique linear relation between minimum wall thickness and stress at the 90-deg points for equal load." The stress node locations allow enough room for all strain gages to be placed inside, end on end.

To meet specifications calling for simplicity, versatility, stability, serviceability, ruggedness, accuracy and attractiveness, the ring had to be encapsulated rather than sealed in a can. Non-rigid epoxies were tried, but failed to remain flexible over the wide temperature range to which the unit would be subjected. A silicone rubber that cures at room temperature (RTV 501) was found to be ideal for all operations above −65 F. The material is easily applied with a plastics syringe and entrained air is easily removed in a bell jar.

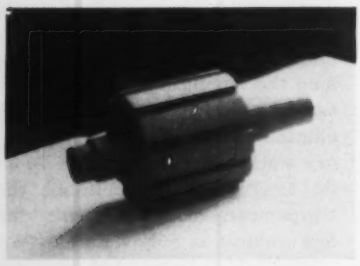
For service temperature below −65 F, another formulation (RTV S-5302,3) is used. This material has a putty-like consistency and is spooned in place.

Both materials provide excellent protection against water vapor, grease and fuels, dirt, and impact. They also lend themselves well to ring repair. To replace a defective strain gage or damaged cable, a section of the potting compound is simply cut out and the area repaired by either of the two encapsulating procedures.

Urethane Elastomer Is Durable Coating for Pinch Roll

$50 CITATION

by Arthur F. Ringwood, Materials Engineering Dept.
General Engineering Laboratory, General Electric Co.,
Schenectady, N. Y.



Typical pinch rolls.

■ Mechanical strength, frictional properties and adhesion were the primary factors in selecting a ⅜-in. liquid cast urethane elastomer with an epoxy primer for coating steel pinch rolls.

The wear problem

The pinch rolls are used for pulling and straightening heavy copper wire, 1.5 in. wide by 0.5 in. thick, prior to feeding the wire into a stator-bar forming machine. Coating requirements included low compression set, high abrasion and tear resistance, and high frictional coefficient. The coating had to withstand a minimum of 1500 psi shear stress, and a surface pressure of 8000 psi.

The original coating had been a 60-durometer natural rubber. It began to show surface spalling and wear during trial runs. Several grades of neoprene were evaluated, but grades providing sufficient mechanical properties proved unsatisfactory due to peeling and/or tearing.

Liquid elastomer is answer

A liquid urethane elastomer (Du Pont's Adiprene L) was finally selected on the basis of both properties obtainable and ease of processing. An epoxy prime coat was found necessary to provide the desired adhesion.

The steel rolls were cleaned and given a 10-mil prime coat of an amine-cured epoxy resin (Shell Chemical's Epon 820). After cure of the primer, the roll was placed in a clean steel mold which had been coated with a silicone mold release (Dow Corning's R-671). The urethane was mixed, slightly modified with castor oil, and poured.

The resulting coating formed a strongly adherent, abrasion and chemical resistant surface.

The material

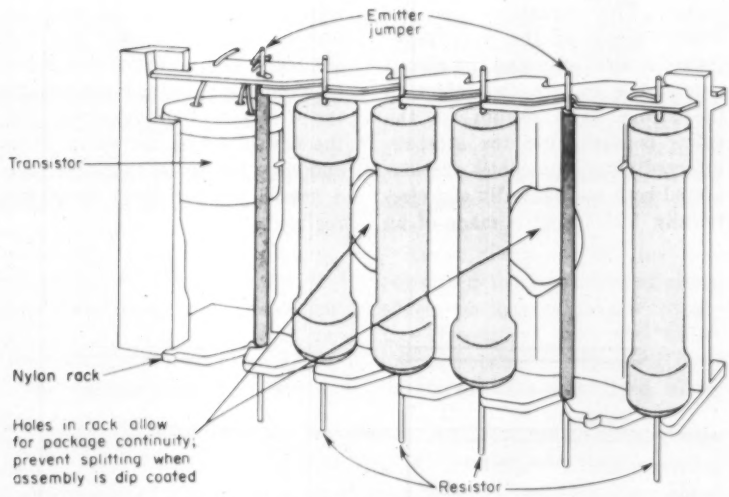
The elastomer was 80-durometer stock, with a tensile strength of 3950 psi, 200% modulus of 1700 psi, Graves tear strength of 350 psi, and compression set of 9% (22 hr at 158 F).

Such coatings can be varied widely to alter physical properties. The more flexible types can be pre-cast to the desired thickness and cemented to the rolls with epoxy primers or adhesives.

Components of Logic Element Package Snap On to Nylon Rack

$50 CITATION

Andress Kernick, Aircraft Equipment Dept., Small Motor Div., Westinghouse Electric Corp., Lima, Ohio


Emitter jumper
Transistor
Nylon rack
Holes in rack allow for package continuity; prevent splitting when assembly is dip coated
Resistor

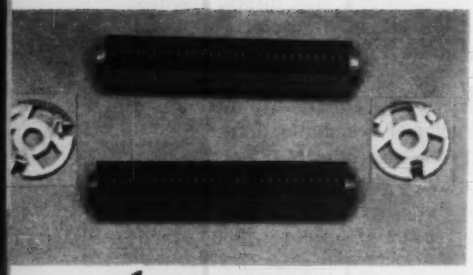
Components *of NOR logic element module.*

■ The Westinghouse NOR logic element package was redesigned to allow the use of a snap-on rack method of assembly. Use of the snap-on rack eliminates conventional costly insertion of all parts except the transistor. In addition, a simplified, less defect-prone printed circuit can be used. Positioning of components in the rack is maintained without extensive manipulation of transistors, rectifiers, etc.

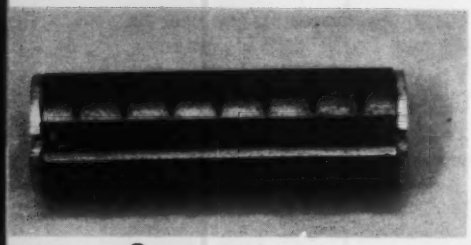
Heart of the redesign is the nylon rack which simplifies accurate positioning of components. Nylon is a good electrical insulator. Other design requirements that the rack material had to satisfy include:

1. Resilience and friction coefficient with the axial leads such as to allow sharp "snap-in."
2. Plastic "memory" to compensate for distortion during assembly.
3. Good moldability because of the rack configuration.
4. Mold life expectancy of 500,000 parts.
5. Thick, sticky consistency at the temperature induced by the molten dip solder.

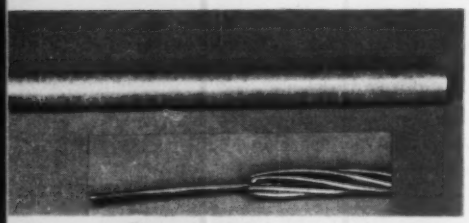
Frangibility of Metal Powder Parts Used in Cable Connector



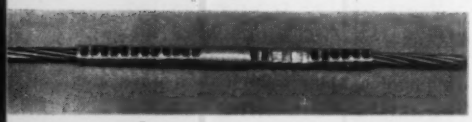
1 ***Jaws*** *of metal powder liner are combined with aluminum washers to make . . .*



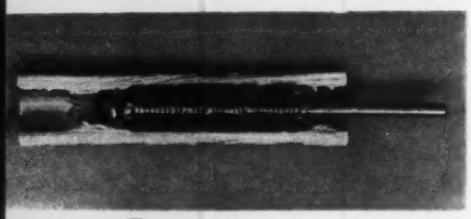
2 ***. . . assembled liner*** *which is inserted in aluminum sleeve.*



3 ***Aluminum wire,*** *with steel reinforcing wire exposed for entry into metal powder liner, is inserted into aluminum tube and . . .*



4 ***. . . assembled connector*** *is crimped to lock sleeve to cable and crush jaw of liner into steel reinforcing wire.*



5 ***Inside look*** *shows cable locked to sleeve.*

$50 CITATION

Robert F. Cobaugh,
Project Engineer
AMP, Inc., Harrisburg, Pa.

■ The frangibility of metal powder parts, usually considered a detriment, has been used to advantage in the redesign of an electrical connector for steel-reinforced aluminum transmission (ACSR) cables.

New design vs old

In the old design steel wire was joined to an aluminum sleeve by twisting, hooking and swaging with a large connector. After swaging, an additional aluminum sleeve was applied to the connector to terminate the electrical portion of the transmission cable.

In the new design a serrated metal powder liner or insert in the connector is intentionally broken when the connector is swaged onto the cables being connected. The serrations on the broken pieces of the liner penetrate the steel wire and the aluminum sleeve to lock the cables to the sleeve. The design of the splice is such that the steel-reinforced aluminum cables are connected both mechanically and electrically. The insert is made of an iron powder containing copper and carbon.

Big advantage of the new design is that much less material is used than in the old design. Size of the connector has been reduced about one-third. Other advantages:

1. Wire can be spliced in 6 min with the new connector, compared to 30 min for the previously used connector.

2. The powder metal insert costs a few cents, compared to 50¢ for the previously used machined part.

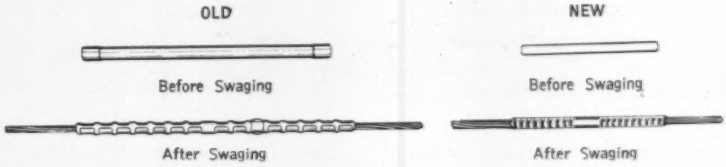
3. The smaller size of the connector minimizes warpage during swaging.

Service requirements met

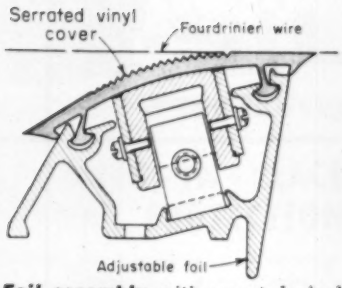
ACSR cable spliced with the new connector meets all existing service requirements for heat and corrosion resistance, and tensile strength. Creep data show an insignificant amount of creep under the heaviest type of loading for transmission or distribution cables.

Other materials considered

Castings and wrought steel were also considered for the connector insert. Wrought steel did not break and no splice was made between the aluminum sleeve and the steel wire. Castings broke, but the advantage of the sharp teeth and close tolerances available with a metal powder part were not realized.



Comparison *of old and new designs.*



Foil assembly *with serrated vinyl cover in position on the underside of fourdrinier wire.*

Vinyl extrusion *does not erode or distort in the corrosive atmosphere of a papermaking machine.*

Semi-Rigid Vinyl Extrusion Helps Speed Up Paper Production

$50 CITATION

Harold E. Dunlap, Chief Draftsman
Lodding Engineering Corp., Auburn, Mass.

■ A new design concept in papermaking machinery uses a foil in place of conventional table rolls and deflectors to speed the drainage of water from paper stock on the fourdrinier wire. The acute angle at the leading edge of the foil (see accompanying sketch) serves to cut or "doctor" adhering water from the underside of the wire belt. The rear portion of the part, which is slightly inclined from the plane or wire movement, creates a vacuum to induce drainage of water from the paper stock. The latest design uses an adjustable foil to eliminate the time consuming trial-and-error methods previously needed to determine correct inclination angle.

The materials problem was to find a replacement for the laminated phenolic material formerly used as the cover for the foil. The phenolic swelled and wore in uneven patterns. In addition, it could not be machined sharp because of the possibility of chipping, fraying or delaminating the material. The resulting bluntness of the leading edge adversely affected its ability to cut water from the underside of the wire.

Vinyl extrusion replaces laminated material

A switch from laminated phenolic to a semi-rigid vinyl extrusion as a cover for the leading edge of the foil has resulted in a low cost part that performs well under operating conditions.

Reason: the use of vinyl has permitted the extrusion of sharp edges, which, combined with surface smoothness, minimize "build-up" of paper stock frequently encountered with laminated materials. Other advantages:

1. The vinyl cover does not erode or distort in the corrosive atmosphere as did laminated phenolic covers.

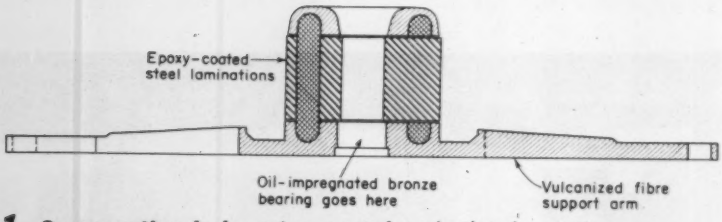
2. Because of its flexibility, the vinyl cover conforms well to the underside of the wire belt, with uniform wearing characteristics. The need for periodic resurfacing is eliminated.

3. The vinyl extrusion is produced at a cost of about 50¢ per ft, compared to machined shapes of laminated phenolic which cost $4 to $15 per ft.

4. Flexibility of the vinyl extrusion causes the leading edge of the foil to deflect slightly if pressure develops between the wire and the vinyl cover. Thus, the leading edge has a certain degree of self adjustment if needed.

The design of the leading edge provides a flat surface on which the weight of the wire and paper stock is distributed and supported evenly. The small serrations in the center section of the extrusion are designed to trap "fines" from the paper stock, thus providing a more wettable surface than provided by a part without serrations.

Other parts in the foil assembly are made of aluminum extrusions. The extrusions are anodized and protected with five thin coats of a butoxy resin, individually cured.



1 ***Cross-sectional view*** *of compact, long lasting fan part.*

$50 CITATION
Engineering Dept.,
Rotron Mfg. Co., Inc.,
Woodstock, N. Y.

Epoxy-Glass Encapsulation Provides One-Piece Fan Assembly

■ A compact, long lasting fan part has evolved through the use of eight materials: steel, copper, epoxy, nylon, vulcanized fibre, tin, fiberglass and bronze.

The part, called a spider, combines in one piece the laminations, winding, stator, oil reservoir, bearing, insulation, terminals and means of mounting for an electric motor in a fan. Fig 1 is a cross-sectional view of the part.

Advantages

The fan has a design life of five years at room temperature. However, accelerated tests show it can operate satisfactorily for thousands of hours at much higher temperatures.

The encapsulated assembly has good resistance to high potential shorting, humidity, heat, thermal shock, dimensional change and handling, and performs well both mechanically and electrically. It lends itself well to rapid assembly.

Here's how the spider is put together

1. The laminations of electrical grade steel are assembled with two steel rivets and two copper shorting coils welded at the ends. Steel magnetic bridges are inserted in slots in the stack. An insulating and supporting arm of vulcanized fibre, bent in the shape of an L, is inserted behind the magnetic bridges. The mounting arm contains two tinned rivets for terminals to which two nylon-coated copper wires from the winding are soldered.

2. The stack is coated with epoxy powder by the fluidized bed process which produces a coating 0.010 to 0.030 in. thick. The cured coating has excellent dielectric properties and insulates the winding wire from the steel laminations. The winding wire itself is 0.005-in. dia copper coated with nylon. The wire is wound by means of an automatic machine.

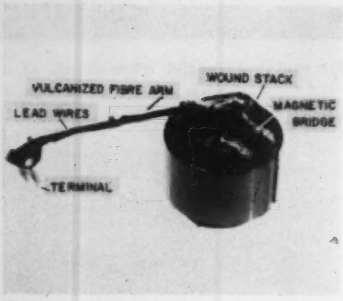
3. The subassembly is placed in a steel mold and encapsulated with a single-component fiberglass-filled epoxy compound by transfer molding. The fiberglass-epoxy compound surrounds and protects the windings and the vulcanized fibre mounting arms (see Fig 2).

Transfer molding was selected as a means of encapsulating the assembly because it gives parts with good appearance.

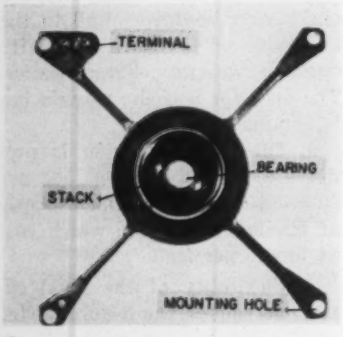
The assembly was previously encapsulated with a mineral-filled two-component epoxy. The process used inexpensive molds, and was moderately satisfactory for prototype production. However, many difficulties were experienced with mold and machine maintenance, and with voids in the encapsulated assembly.

5. A porous sintered bronze bearing that has been vacuum impregnated with a high grade oil is press fitted into a hole in the center of the encapsulated subassembly.

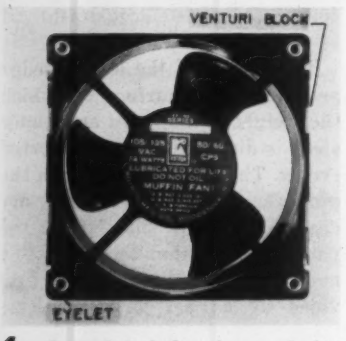
6. The subassembly (Fig 3) is then joined to a propeller to form a highly efficient cooling fan for electronic applications (Fig 4).



2 ***Subassembly*** *is encapsulated with a fiberglass-filled epoxy compound by transfer molding.*



3 ***Encapsulated part*** *with porous bronze bearing is ready for assembly with a propeller.*



4 ***Completed fan*** *has a design life of five years at room temperature.*

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first in silicones

Dow Corning

SILICONE NEWS

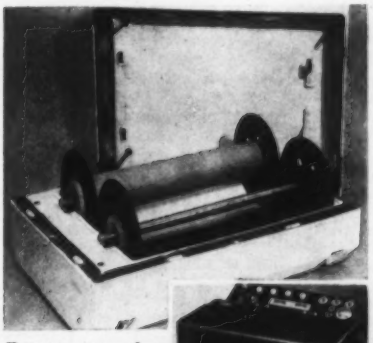
for design and development engineers • No. 74

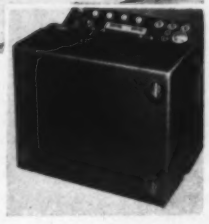
A FOAMED-IN-PLACE SILICONE PROTECTION

Engineers at Consolidated Electrodynamics Corporation have found a foam-in-place silicone resin ideal for protecting the magazines of oscillographs used to gather vital data during dynamic testing studies of variables affecting aircraft performance.

CEC's Recording Oscillographs are capable of simultaneously making permanent, photographic records of up to 50 factors affecting performance. These instruments record information in terms of electric current and catalog all phenomena in true relation to time and to one another.

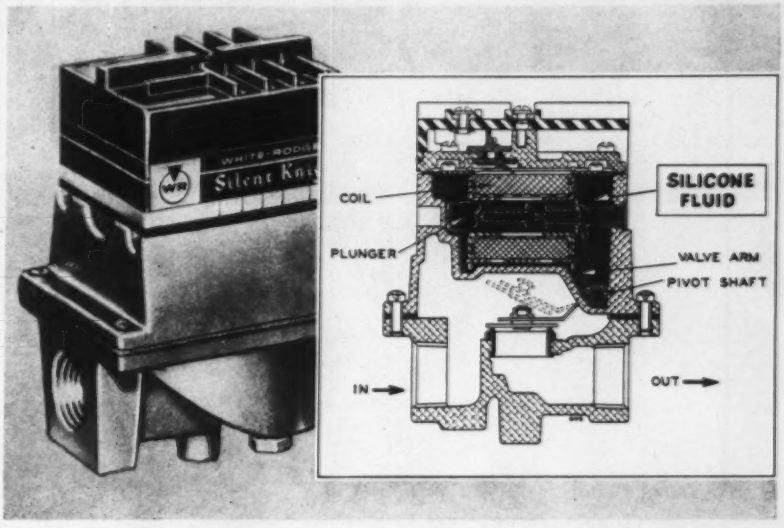
To be certain that these critical data will be preserved for study through all eventualities, even when experimental aircraft must be ditched, CEC designed and built the first effective crash-resistant storage magazine. The magazine is housed in a ductile-iron casting surrounded by a stainless steel shell. It's protected against heat and shock by a silicone resin foam that fills the space between casting and shell.





Easy to use, the Dow Corning silicone foaming powder is simply poured in place and heated. Heat causes the powder to melt and foam, completely filling the void. Additional protection is provided by painting the outer steel shell with a fire resistant paint that foams at 300 F.

How effective is the Dow Corning silicone foam? CEC estimates the magazine will withstand a shock of 400-g's followed by a fire as hot as 2,000 F! In addition, the magazine is explosion-proofed in accordance with MIL-E-5400 A (ASG). *No. 241*



SILENCES GAS VALVES

Use of silicone fluid has enabled White-Rodgers Company, St. Louis, to produce gas valves that give completely silent service on such units as central heating, floor and wall furnaces, conversion burners, boilers, unit heaters and room circulators. Here's how:

White-Rodgers' engineers effectively eliminated operating noises by immersing the entire operating mechanism of the new Silent Knight Gas Valves in Dow Corning 200 Fluid. Enclosed in an unbreakable metal case, the viscous fluid slows the mechanism, cushions the components and makes them silent. Eliminated are the characteristic "snap" of the relay, the "hammering" of the plunger. In addition, by damping the opening action of the valve, some of the undesirable "pop" of the gas ignition is eliminated.

Silicone fluid proved the ideal damping medium because it doesn't thicken or thin with temperature changes, thus assuring consistent, uniform damping far beyond the capabilities of previously available damping oils. This fluid's noncorrosiveness and resistance to oxidation and to breakdown under shear assures long-time reliable service.

What's more, Dow Corning 200 Fluid's remarkable thermal stability helped simplify the design and increased the reliability of the gas valve by eliminating the need for rubber diaphragms or bellows in the fluid chamber. *No. 242*

New Guide To Silicones In Electronics

First availability. A complete and comprehensive reference guide to the silicone materials that meet exacting electronic requirements.

This recently published 12-page engineering guide explains how various physical forms of silicones contribute to reliability, miniaturization, modularization and environmental protection; increase serviceability over wide extremes of temperature; and aid value engineering.

Well illustrated, this new "materials handbook" contains silicone engineering data and processing information . . . details the important electrical and mechanical properties of the silicones most useful in electronics . . . describes typical applications for silicones in every area of use — from satellites to seismographic instruments, from computers to servo motors.

To obtain your free copy, circle—*No. 243*

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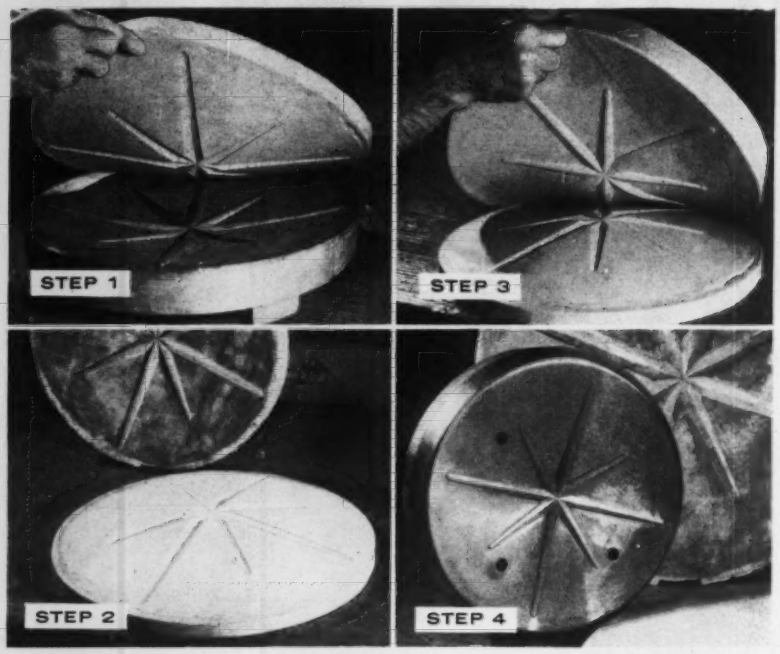
MORE



HOW TO MAKE PROTOTYPES

Silastic® RTV provides a new and better way to make prototypes. Here's how one automotive parts supplier — Cadillac Stamp Company, Detroit — uses this Dow Corning room-temperature-vulcanizing silicone rubber to make templates for hubcap embossing dies.

STEP 1. Silastic RTV is poured onto a wood pattern machined to the exact configuration of the hubcap design. With its fluid consistency, Silastic RTV flows into and around complex shapes and intricate and deep draws—then vulcanizes at room temperature to produce a strikingly accurate "negative" mold.

STEP 2. A plastic "positive" of the original pattern is then cast in the Silastic RTV mold. This "positive" forms a prototype from which a pantograph-type engraving machine can sink female dies.

STEP 3. Next, more Silastic RTV is poured into the original silicone rubber "negative" mold made of Silastic RTV to form another RTV "positive". After this new charge has vulcanized in the mold the two are separated. Coating the mold with a release agent facilitates clean and quick separation of the new "positive".

STEP 4. A plastic form is now cast from the Silastic RTV "positive". This plastic template is used in guiding the engraving machine in producing male sink dies. In this process, size is reduced by one-half.

An economy feature: Thanks to Silastic RTV both embossing dies are made from one wood original.

For more information, circle . . . *No. 244*

SEE US AT BOOTH 1915

Make it a "must" to stop by . . . for a quick check of the latest developments in the rapidly moving field of silicones . . . .

1960 DESIGN ENGINEERING SHOW — NEW YORK COLISEUM — MAY 23 - 26

new literature and technical data on silicones

Radiation Stability of Silicone Greases is the subject of an article from Lubrication Engineering. Graphs and illustrations resulting from evidence compiled during an extensive test program point up the degree of radiation stability of silicone fluids. These characteristics help project the utility and stability of silicone greases. A valuable reference piece for advance design and development engineers. *No. 245*

Design Versatility — Lightweight, strong, inert, and easy to fabricate, silicone-glass laminates are used in the design and manufacture of a variety of consumer and industrial products. Applications, tables of physical and dielectric properties, illustrations of various parts, and sources of silicone-glass laminate parts are included in a 4-page brochure. *No. 246*

How To Make Coils more easily . . . and also get better performance . . . is the subject of a compact 8-page booklet reprinted from NISA News. The use of triangular Guideline Tape facilitates and speeds wrapping — provides the good electrical properties, thermal stability, chemical and moisture resistance characteristic of Silastic®, the Dow Corning silicone rubber. This reprint contains helpful graphs, tables, and illustrations. *No. 247*

Wherever There's A Problem — gaskets, seals, O-rings . . . rubber parts fabricated of Silastic, the Dow Corning silicone rubber stay rubbery in spite of heat, cold, compression, weathering or ozone, moisture or steam, oils, fuels, or chemicals that often cause problems. This six-page illustrated brochure cites how these common problems are overcome by the use of Silastic . . . to increase the life and reliability of scores of units while reducing maintenance costs and frequently simplifying design. *No. 248*

You And The Silicones — a new 30-minute, full color movie lets you see silicones in action. It's an all-encompassing, dramatic documentation of designers' adaptations of these versatile engineering materials in different applications. For information about arranging for a free showing, request . . . . . *No. 249*

Designs on the Moon. Created specifically to meet the informational needs of rocket and missile designers, an illustrated brochure describes the finest in silicone materials — rigid, rubbery, fluid and dielectric. Whether you're concerned with nose cones, guidance frames, propulsion, or ground supports, your most rapid progress toward miniaturization, weight reduction, and reliable performance may result from specifying silicone products. *No. 250*

Dow Corning Corporation, Dept. 7005, Midland, Michigan

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FILE FACTS

Immersion Coatings

Immersion coatings are applied without electricity by immersing parts in a chemical solution or bath containing the metal to be deposited. Deposition can take place either by displacement, where the metal in solution displaces the base metal, or by reduction, where the base metal does not enter into the reaction.

Although many metals can be deposited in immersion baths, comparatively few have proved acceptable for decorative or functional applications. These are: nickel, tin, copper, gold and silver.

Electroless nickel

Properties—Electroless nickel is generally more expensive than electroplated nickel. For this reason it is used primarily for its functional properties, although a very smooth, bright deposit can be obtained on buffed ferrous and nonferrous metals.

Because of its amorphous structure and phosporus content (8 to 10%) the coatings are said to have better corrosion resistance than electrolytic or wrought nickel. Hardness of the coatings is relatively high—about 50 R_c—and can be raised to 64 R_c by heat treatment. Thickness of the coatings ranges from 1 to 5 mils, depending on end use.

Applications—The most important uses for electroless nickel are to protect parts from corrosion and to prevent product contamination. The coatings are widely used on tank car interiors to protect caustic soda, ethylene oxide, tetraethyl lead, tall oil and many other liquids from contamination. Other similar applications include: oil refinery air compressors, missile fuel injector plates, gas storage bottles for liquid rockets, and pumps for petroleum products.

The hardness of the coatings is particularly valuable in increasing the life of rotating and reciprocating surfaces in gas compressors, pumps, hydraulic cylinders, sheaves and armatures. The coatings are also used on aluminum electronic devices to facilitate soldering, on stainless steel to facilitate brazing, on moving metal parts to prevent galling, and on stainless steel equipment to prevent stress corrosion cracking.

Tin

Properties—Tin immersion coatings are especially noted for their low cost, bright appearance, good frictional properties, and ease of application to many common metals such as copper, brass, bronze, aluminum and steel. However, their corrosion resistance is only fair.

As with some other immersion coatings, plating usually stops when the base metal is completely covered. Thus, thickness for common decorative uses is limited to about 0.015 mil. However, thicknesses up to 2 mils for heavy duty applications have been produced by placing the base metal in contact with a dissimilar metal, thereby generating current and promoting additional plating.

Applications—Tin immersion coatings are popular for decorative finishing of small parts such as safety pins, thimbles, and buckles. They are also applied to copper tubing to prevent discoloration from water, and to aluminum engine pistons to provide lubrication during break-in periods.

Copper

Properties—The most important characteristics of copper immersion coatings are their high electrical conductivity, good lubrication properties, and unique appearance. In addition to steel, they can be applied to brass and aluminum and to printed circuit boards. Usual thickness range is 0.1 to 1 mil.

Applications—Because of their conductivity, copper immersion coatings have proved particularly useful for printed circuits. They are not especially noted for their decorative appeal, but can be used in applications where a particular appearance is required; e.g., inexpensive, decorative hardware such as casket parts. Because of their good lubrication properties they can also be used on steel wire in die forming operations.

Gold

Properties—Gold immersion coatings are relatively inexpensive because of their extreme thinness —about 0.001 mil. The coatings have good electrical conductivity and emissivity characteristics, and a bright, attractive appearance. As deposited they are not especially resistant to discoloration and abrasion; however, they can be protected with a clear lacquer finish. They are used on a wide variety of ferrous and nonferrous metals, and on copper printed circuit boards.

Applications—Because of their good appearance gold immersion coatings are principally used on costume jewelry, trophies, auto trim and inexpensive novelties. Their conductivity and solderability are used to advantage in electrical applications such as printed circuits, transistors and connectors. Also, the unique emissivity properties of the coatings have proved useful in missile applications.

Silver

Properties—Like gold, silver immersion coatings are relatively inexpensive because of their extreme thinness. The coatings have a bright, attractive appearance when first deposited. Their resistance to tarnishing and abuse is poor; however, they can be protected somewhat with a clear lacquer coating.

Silver immersion coatings can be applied to most base metals except lead, zinc, aluminum and very active metals. They perform best on copper, nickel, and steel. Usual thickness is about 0.001 mil, but 0.03 mil can be deposited in some cases.

Applications—Because of their poor durability silver immersion coatings are not too popular, the only applications being cheap decorative products, minor electronic parts and maintenance plating.

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MATERIALS AT WORK

...AT A GLANCE

Switch from die castings to zinc-coated steel sheet has resulted in faster assembly, better performance and reduced cost of valves used in water pressure tanks. Originally, the valves consisted of two cup-shaped die castings joined by bolts with a diaphragm between. Now, the valves are formed from the zinc-coated steel sheet and the diaphragm inserted. After forming, the parts are locked together by a reverse draw that creates an airtight seal.

Source: Armco Steel Corp.; valves made by Brady Air Controls, Inc.

Water reducible primers are protecting automobile interiors against corrosion. A unique production setup makes it possible to spray hard-to-reach areas on the inside of doors as automobile bodies emerge from a dry-off oven. Heat from the hot body sets and cures the primer. Underbody structural members are coated by immersion in a tank. Excess primer is removed from the exterior by a water rinse to permit coating with conventional baking enamels.

Source: C. O. Durbin, Chrysler Corp.

Alumina ceramic nose cones have been specified for the Navy's Sparrow III guided missiles. Alumina offers high strength, excellent resistance to thermal shock and excellent resistance to accelerated erosion normally experienced by nose cones traveling through rain clouds at supersonic speeds. It is also uniformly transparent to radar waves—a vital factor in guidance systems.

Source: Aluminum Co. of America; nose cones fabricated by Gladding McBean & Co.; Sparrow III produced by Raytheon Mfg. Co.

Polyethylene sheets containing boron are now being used as radiation shields aboard atomic-powered vessels. The sheets, said to provide excellent protection against neutron bombardment, are lighter than conventional materials such as lead and concrete. They are produced by a special extrusion technique and are so thick they must be cut by specially designed saws.

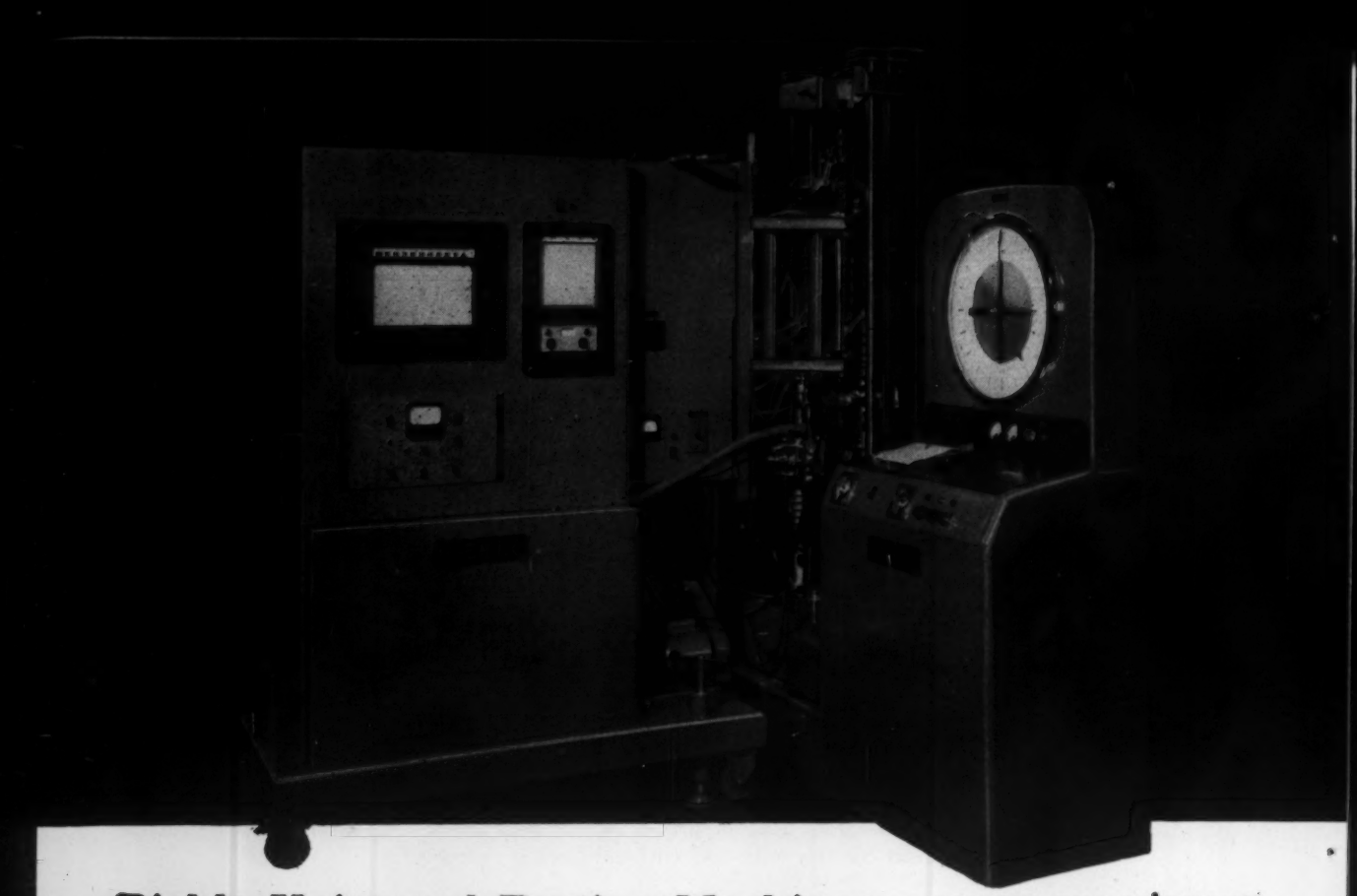
Source: U. S. Industrial Chemicals Co., Div. of National Distillers & Chemical Corp.; radiation shields produced by Panelyte Div., St. Regis Paper Co.

The first all-plastic golf course irrigation system will soon be completed at Lake Tahoe, Calif. The system, which uses over 12,000 ft of rigid vinyl pipe and fittings, will extend over more than 50 acres with a ground level rise of about 80 ft. Advantages of vinyl: it weighs only one-fourth as much as steel, thus reducing shipping costs and installation time; it is resistant to corrosion; and its mirror-smooth interior surface permits a flow rate as much as 25% greater than that of metal pipe.

Source: B. F. Goodrich Co., Industrial Products Div.; system installed by E. E. Luhdorff Co.

Rubber liners for Minuteman missiles are now being molded instead of machined. The cylindrical liners, which are nearly 5½ ft long and slightly more than 3 ft in dia, are used to prevent solid fuel from burning through the motor casing and causing failure of the rocket. The liner is designed to "burn out" simultaneously with the expulsion of the solid propellent, thereby reducing the weight and gage of the casing and leaving the mass ratio at its greatest when the rocket reaches peak altitude.

Source: Goodyear Tire & Rubber Co, Aviation Products Div.; Minuteman made by Boeing Airplane Co.



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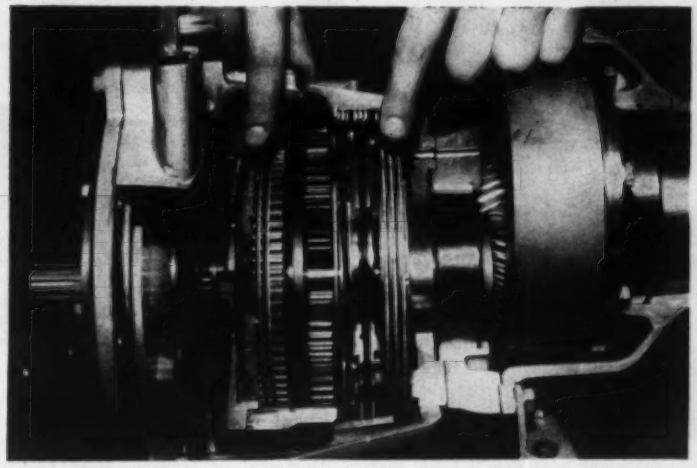
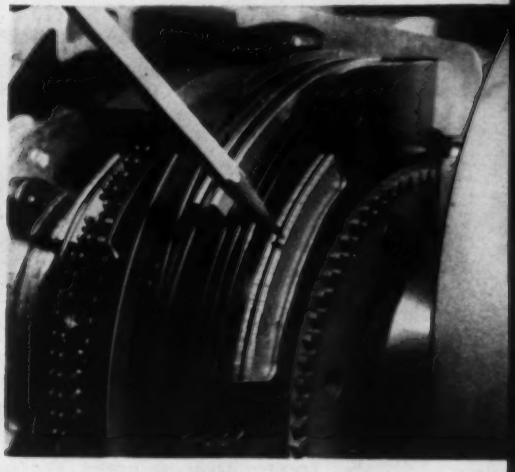
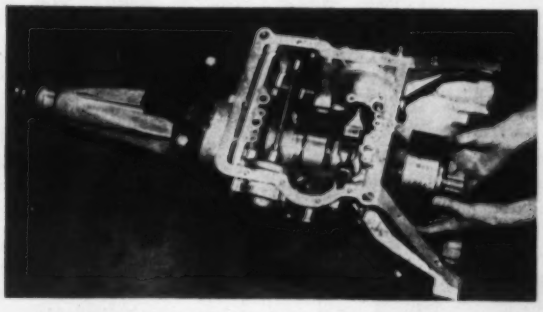
Six Uses of Friction Materials Show Many Service Conditions Possible

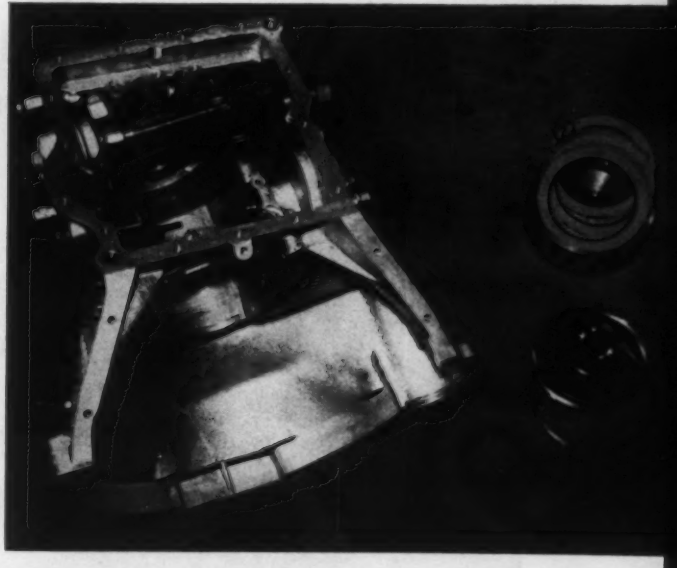
■ Friction materials, particularly those suitable for oil operation, must withstand many different combinations of end-service and environmental conditions. The photos show a number of varied applications and the materials required to satisfy them. Information and photos were supplied by Raybestos-Manhattan, Inc. which manufactures a variety of friction materials. For detailed information on friction materials, see "Selecting Friction Materials," M/DE, Oct '57, p 130 and Nov '57, p 134.



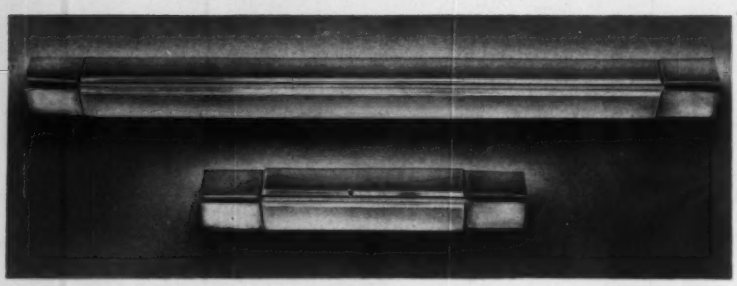


1 ***Aluminum marine transmission.*** Clutch facing (see closeup at right) must have a high coefficient of friction in the presence of oil. The friction material is full metallic—0.015-in. sintered bronze on 0.070-in. steel plate. The design provides the strength to withstand 4000 rpm and makes it possible to operate within narrow clearances ranging from 0.007 to 0.010 in. while maintaining constant friction under all conditions.





2 ***Automatic transmission.*** Friction material requires high static torque capacity, good durability, and resistance to high pressure, as well as resistance to the oils and fluids involved. This transmission (Fordomatic) is shown disassembled at the right to illustrate 1) grooved pattern of the semi-metallic transmission band which promotes oil flow and removes heat, and 2) semi-resilient clutch facing which is bonded to a steel core to provide a 1:1 ratio of static to dynamic friction.



3 Facing for jet aircraft shock strut shoes. *High load stress must be borne by the friction material. Sintered bronze facing is used on these aluminum shoes which operate against aluminum. Facing resists mud, tar and dust, has a stable coefficient of friction, and withstands 18,000 psi stress.*

5 Tractor steering brake. *Friction material must hold heavy loads and control direction for turns and stopping. Full-molded dry process material above exhibits negligible fatigue at high temperatures under abusive conditions, has coefficient of 0.58.*

4 Clutch assembly of power lawn mower. *Good friction coefficients are essential in both dry (0.52 for design above) and oil (0.08) applications. These dry plate disks are resin-bonded, molded asbestos providing high tensile strength and good heat dispersion.*

6 Clutch wheel of fishing trawler winch. *Friction material like the woven asbestos above must take salt water spray and still maintain high coefficient of friction. High friction is necessary to avoid slippage when beveled rim is forced against inner ends of drums to turn winch.*

N. S. Savannah Has Rudder Bearing of Phenolic Laminate

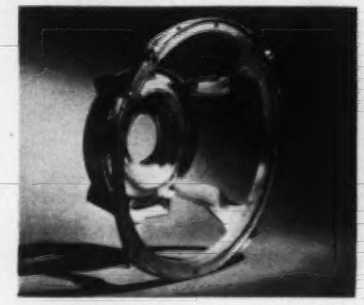
■ When the N. S. (Nuclear Ship) Savannah puts to sea it will be equipped with a rudder bearing made of phenolic-cotton laminate. Although phenolic-cotton bearings have been used in previous ship designs, this application is unusual since the 21,840-ton Savannah is faster than conventional merchant ships and the bearing will have to withstand greater stresses.

The high compressive strength and resiliency of phenolic-cotton laminates are especially suited for this type of application. Furthermore, since the material does not dry out or crack when stored out of water, it only has to be inspected every three years even though the ship is dry-docked annually for other inspections. It also has an advantage over competitive materials (e.g., wood, rubber-and-brass) in that it can be fabricated in one piece.

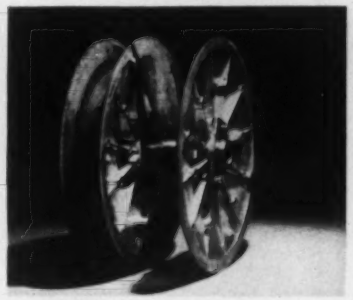
The phenolic-cotton bushing weighs 60 lb and is machined (see photo) from laminated tube (Westinghouse's Micarta) to 26.5-in. length, 16-in. o.d. and 13.75-in. i.d.

Three Prize-Winning Zinc Die Castings

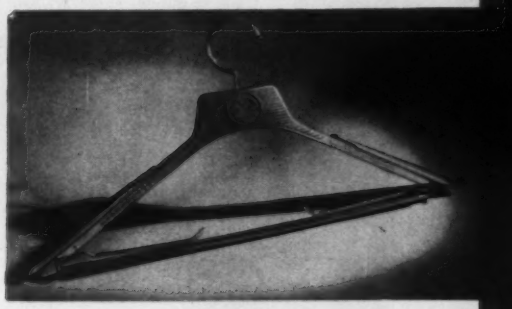
These parts won the first three awards in New Jersey Zinc Co.'s recent contest. Lightweight design was an important consideration.



***Hi-fi speaker basket** has the rigidity and dimensional stability needed to assure permanent centering of the speaker cone, magnetic pot assembly and other components, yet weighs only 2 lb, 12 oz. Nominal wall thickness is 0.040 to 0.050 in. Replacing several stampings with this one casting eliminated costly spinning, finishing and assembly operations. Designer: Bernard C. Sharp, University Loudspeakers, Inc. FIRST PRIZE.*

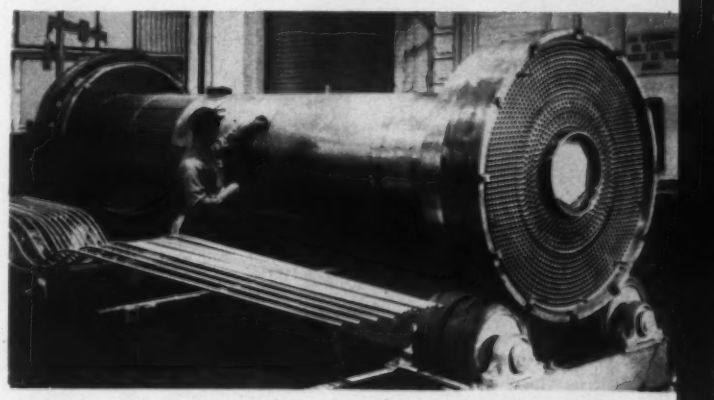


***Conical disk** is key to the speed changing device used on a combination washer-dryer. Four such interchangeable, interlocking disks are used in the device (one is cut away in photo to show how disks mate). The 7½-in. disk replaces steel stampings and machined hubs, resulting in simplified assembly, lower tooling costs and a minimum of machining. Designer: Creighton E. Pool, Home Laundry Engineering, General Electric Co. SECOND PRIZE.*



***Adjustable coat-suit hanger** consists primarily of three thin-wall zinc die castings and has two zinc die cast thumb screws. Spring clip, hook and nameplate are added. Size markings cast into face of main frame make accurate adjustment possible. Hanger is finished with colored baked enamel. Designer: J. W. Anderson, Jr., Monarch Governor Co. THIRD PRIZE.*

Stainless Tubing Carries Sodium Coolant in Nuclear Heat Exchanger



■ The 18-ft long tube bundle shown at right is being checked for diameter in the nuclear "clean room" of Alco Products' plant in Dunkirk, N. Y. The heat exchanger is one of three being built for the Enrico Fermi Power Plant near Detroit.

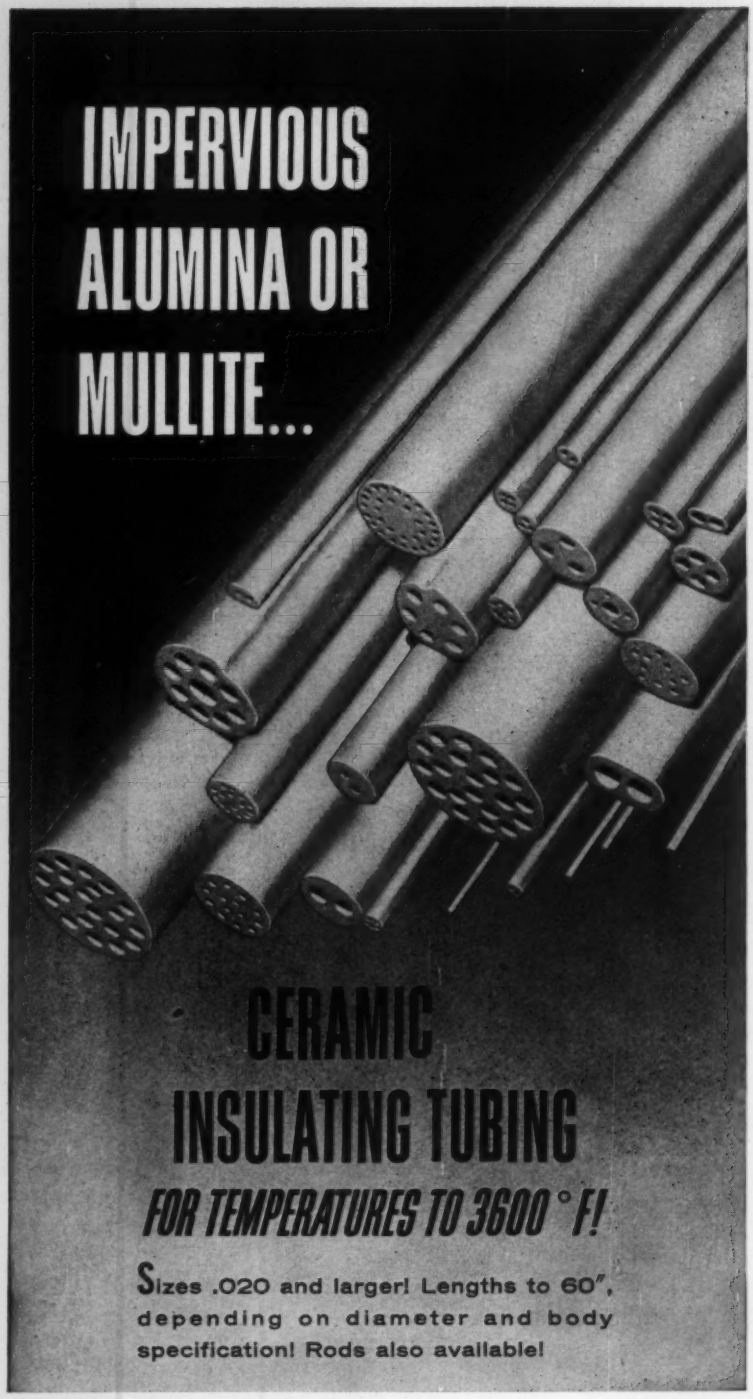
Both tubing and tube sheets are made from Type 304 stainless steel furnished by Allegheny Ludlum Steel Corp.

An unusual feature of the tubing is the sine curve put into it by Alco (see left foreground of photo). This configuration accommodates thermal expansion. The tubing, which is 18 gage and has a ⅞ in. o.d., is bent cold.

The heat exchangers are said to be the largest built to date for use with sodium; one completely assembled exchanger will weigh 130,000 lb. Unlike most nuclear heat exchangers, this one is designed so that the tube bundle can be removed from its shell without cutting apart.

MORE MATERIALS AT WORK

Electrical heating unit..... 172
Stainless cuts missile rejects..... 172
Vinyl plastisol molds..... 174
Titanium missile forging..... 176
Huge earth satellite..... 178
Vacuum cleaner uses deep drawn steel..... 180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MATERIALS AT WORK

Electrical Heating Unit Uses Glass, Graphite

A method of heating by electricity without using a metal element has been developed by Hunting Mhoglas Ltd., Bedfordshire, England.

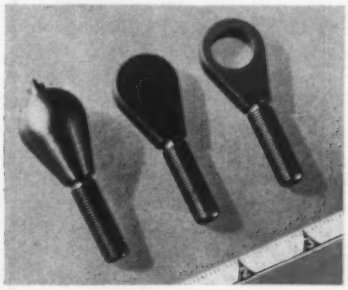
According to Mhoglas, glass fiber is woven into a fabric with a fine net structure which is impregnated with resin-bonded graphite (of a particle size approaching colloidal). Busbars of sprayed zinc or other metal are fixed at each end and connected to a power source. The electrical resistance of the graphite causes the unit to heat up to an even temperature over its entire surface.

The heating system has these advantages: safety, high convection efficiency and long life. Suggested applications include aircraft heating, de-misting windows, maintaining even temperatures in guided missiles, and heating rooms of homes (the units can be incorporated into decorative panels for use as either movable floor units or permanent wall panels).

Switch to Stainless Cuts Missile Rejects

The switch from a chromium-molybdenum alloy steel to a free machining stainless steel for a critical missile part has resulted in 1) elimination of rejects, 2) an 80% increase in production, 3) a smaller number of manufacturing operations and 4) decreased costs.

According to Carpenter Steel Co., the part was originally made by



***Missile part** is now machined from 416 stainless steel.*

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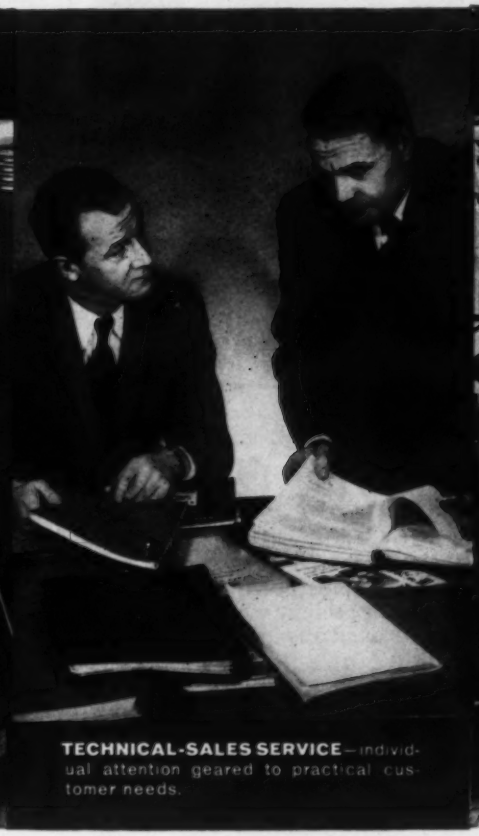

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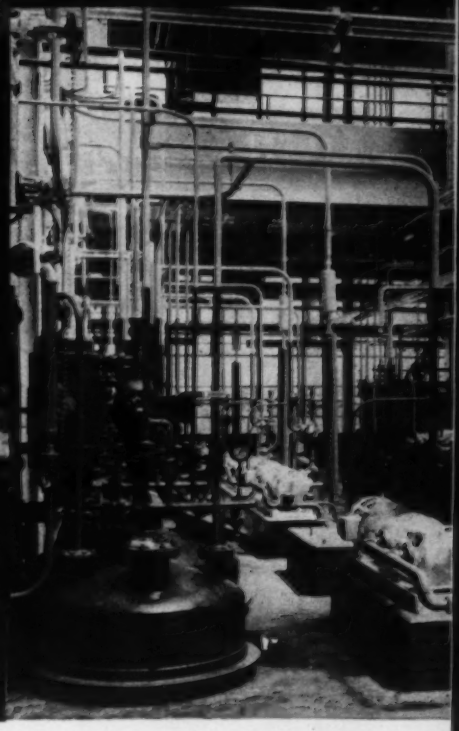
PRODUCT QUALITY—through manufacture of its own basic raw materials CIBA controls the quality and uniformity of epoxy resin production.



Successful marketing starts with products that set the competitive pace. CIBA Epoxy Resins are helping to build such products in ever-widening fields through effective application of the unique combination of properties found in this remarkable engineering material pioneered and developed by CIBA. "The Epoxy Building Block" a new CIBA booklet presents all general property and application data in handy cross-reference pages, and representative case histories demonstrate the opportunities for new product development and present product improvement CIBA Epoxy Resins are making possible. Your copy may be obtained without obligation by addressing CIBA Products Corporation, Fair Lawn, N. J.

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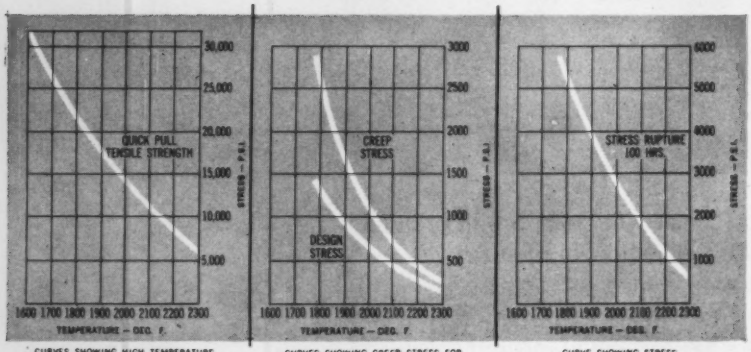
DURALOY HOM*

*Covered by U.S. Patents

casting alloy

Duraloy "HOM" is a special high nickel alloy developed to produce castings that meet high temperature requirements, especially when castings are subject to oxidizing atmospheres.



CURVES SHOWING HIGH TEMPERATURE SHORT-TIME TENSILE STRENGTH OF DURALOY-HOM

CURVES SHOWING CREEP STRESS FOR CREEP RATE OF 1% IN 10,000 HOURS AND RECOMMENDED DESIGN STRESS FOR DURALOY-HOM

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MATERIALS AT WORK

Perfecting Service Co. from 1-in. round AISI 4130 heat treated steel having a tensile strength of 125,000-145,000 psi. The piece had to be worked on a turret lathe, then cadmium plated.

Machinability of the steel was so poor that fabricating, holding tolerances, and finishing presented severe problems. The threads, which had to be machined to pre-plate tolerances, came out far rougher than desired. And no matter how close pre-plate tolerances were held, approximately 25% of every cadmium-plated lot had to be rejected.

The problem was solved by switching to AISI 416 stainless steel. Cadmium plating was replaced by passivating; production increased because of the steel's better machinability; and rejects were completely eliminated.

Vinyl Plastisol Molds Duplicate Stone Work

Precise duplications of hand-carved stone work are now being inexpensively mass produced in vinyl plastisol molds.

According to B. F. Goodrich Chemical Co., colored or natural concrete can be cast in the molds to produce any number of inexpensive reproductions for use in decorative building applications.

Here's how the molds are made: 1) a stone pattern is hand carved; 2) a sand mold is made from the pattern; 3) an aluminum master mold is cast with integral stainless

***Concrete mix** is shoveled into plastisol mold.*

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IOCHROME has displayed a higher degree of ductility compared to other so-called pure chromium metal. The improved ductility was attributed to the high degree of purity.

IOCHROME will be useful in two areas: In the development of high chromium content super-alloys and ductile chromium base alloys.—It is generally accepted that increased chromium content will improve high temperature properties.

IOCHROME makes it possible to add 5 to 10 percent more chromium to certain alloys without impairment of their fabricability or room temperature ductility.

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***Duplicated design** is removed ready for use.*

steel tubing (for heating and cooling); 4) the vinyl plastisol is poured into the preheated aluminum mold; and 5) after cooling, the vinyl mold is stripped from the aluminum mold ready for use.

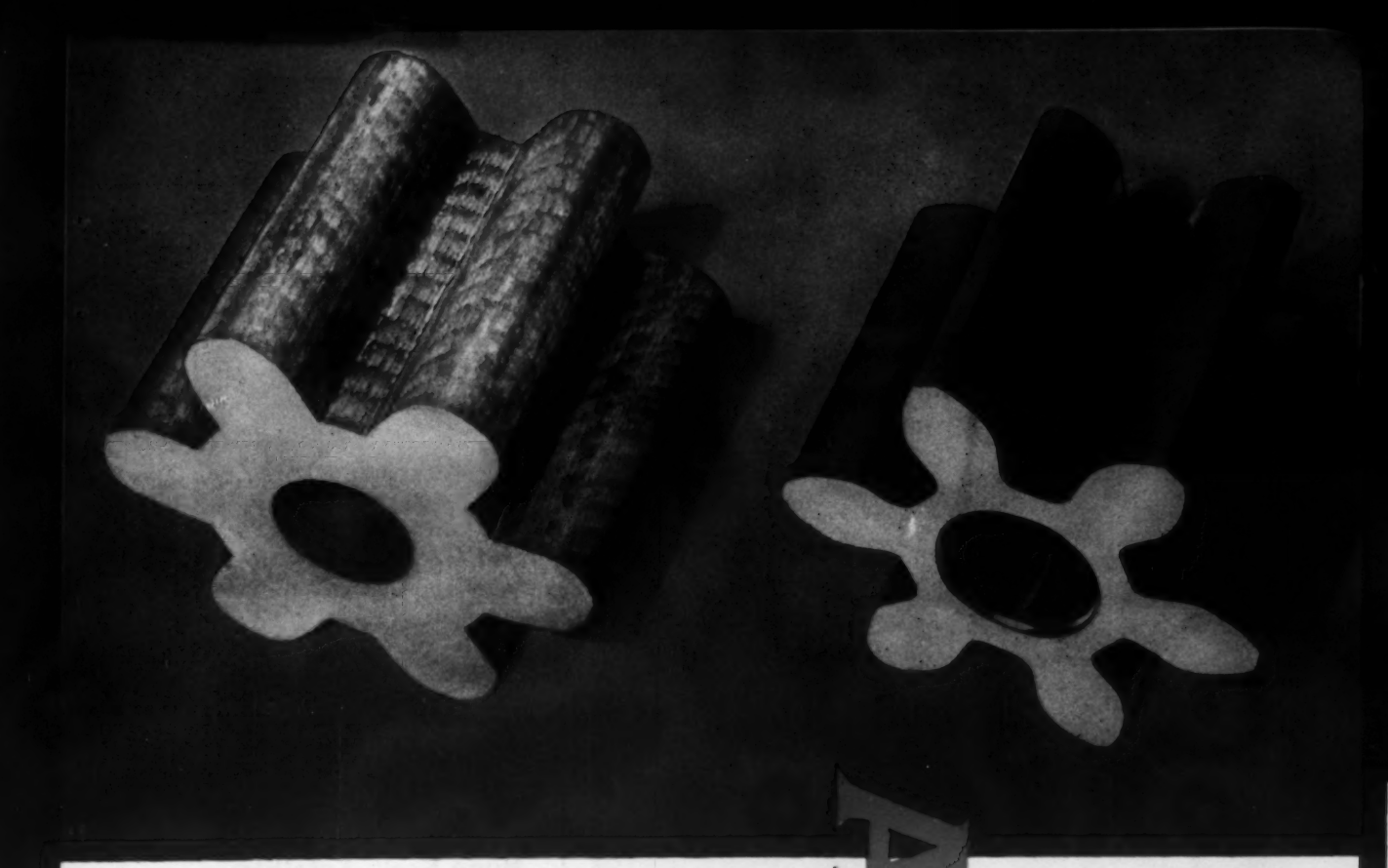
According to Precast Building Sections, Inc., concrete can be poured into the vinyl molds with no further preparation. In the case of very large pieces of stone work, however, the vinyl mold is backed with casting plaster to insure rigidity.

Advantages of vinyl over previously used wood include: considerably reduced cost; flexibility; and ability to produce surfaces that can duplicate almost any desired finish. In addition, an unlimited quantity of vinyl molds can be made from the aluminum master.

Titanium Forging May Increase Missile Range

Thanks to the successful closed-die forging of large titanium motor casing closures (see accompanying photo), new missiles propelled by solid fuel should have either greater range or increased payload.

According to Wyman-Gordon Co., the all-beta titanium forgings weigh 441 lb, have o.d.'s of 41 in., and



Note minimum clean-up necessary between casting of this 6-tooth pump impeller and finished part. (Illustrated parts are 4" in diameter.)

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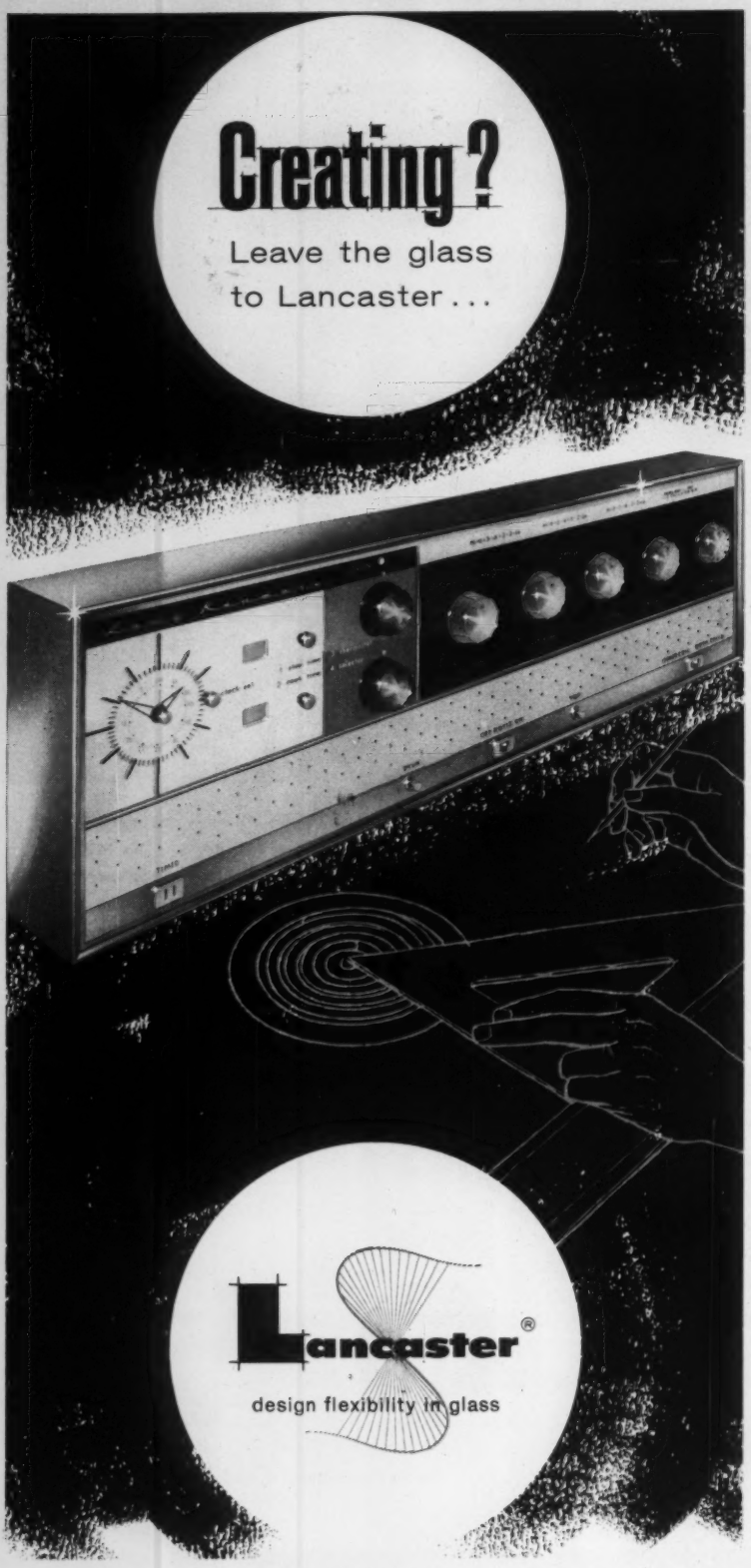

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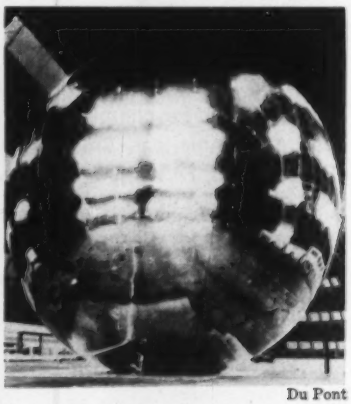
***Forged titanium closure** is raised from bed of 50,000-ton press.*

develop yield strengths of 180,000-200,000 psi, with 4-6% elongation. To achieve equivalent strength-to-density ratio in steel would require a part with a yield strength of 290,000 psi.

Huge Earth Satellite Made of Polyester Film

The gigantic balloon-like satellite shown in the accompanying photo is similar to the satellite that recently soared over the East Coast in an experiment to determine whether earth satellites can be used to reflect communication signals.

The 100-ft balloon consists of 0.0005-in. thick polyester film coated with a thin aluminum reflecting surface. Polyester was selected because it is strong enough to withstand the strain of packing (the balloon is

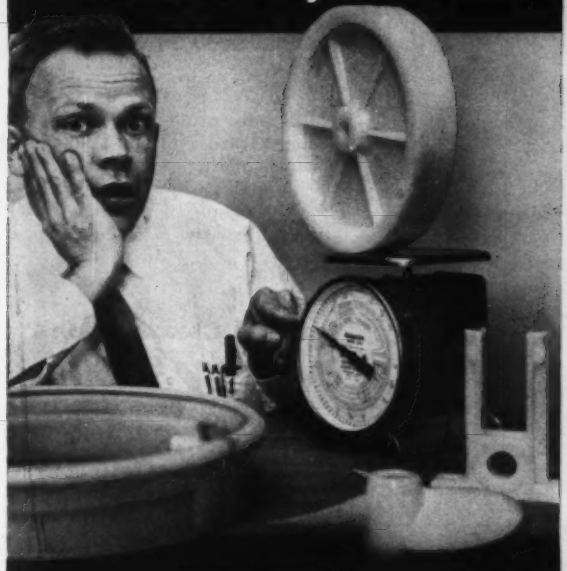


Du Pont

***Aluminum-coated polyester** satellite will be used to reflect communication signals.*

Did you ever hear of

6 LB. CAST Nylon Parts?



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- Machining
- Corrosion
- Abrasion

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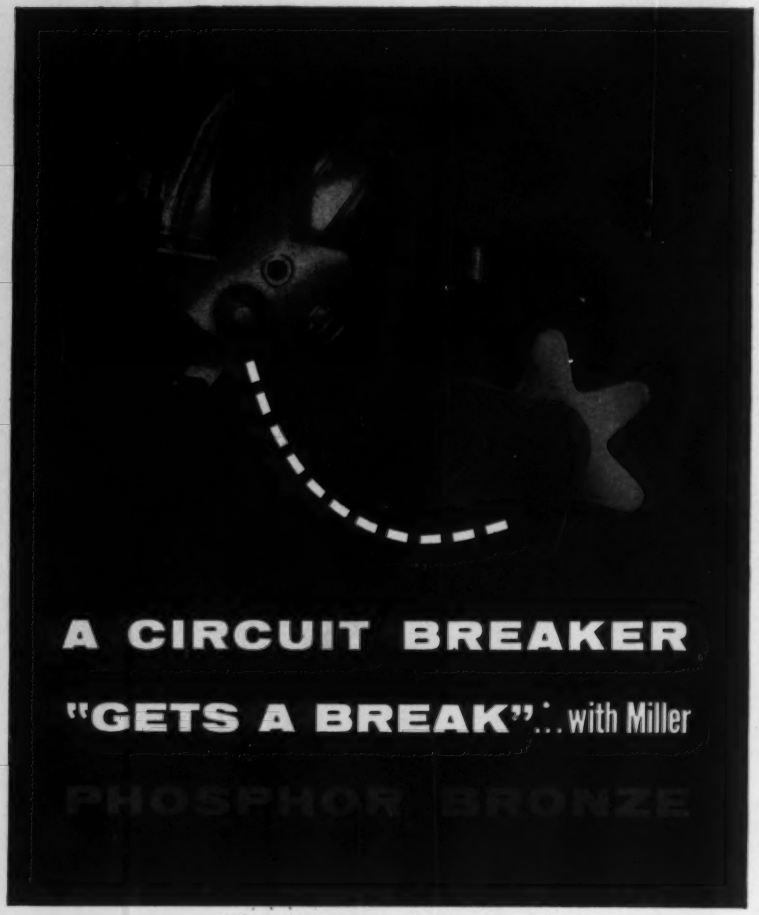

Design engineers for a leading manufacturer of circuit breakers specified phosphor bronze in the star spring of the circuit breaker shown here. Ordinary phosphor bronze was used in the development stage, but spring pressure wasn't uniform, and breakers often failed to open under an electrical overload.

Miller—whose specialty is phosphor bronze—experimented with various alloys and tempers for the phosphor bronze spring until they came up with the right material for the job. They specified Miller Grade A Phosphor Bronze—a material that met the rigid requirements for the job . . . was highly corrosion-resistant . . . and was *less* expensive than the phosphor bronze originally used!

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folded into a 30-in. package for loading aboard a rocket), the effects of rapid inflation, and the rigors of space travel at an altitude of about 800-1000 miles. In addition, it can withstand wide temperature extremes.

Vacuum Cleaner Uses Deep Drawn Steel

The excellent drawability of cold rolled steel sheet is said to play a crucial role in the production of Hoover Co.'s Constellation vacuum cleaners.

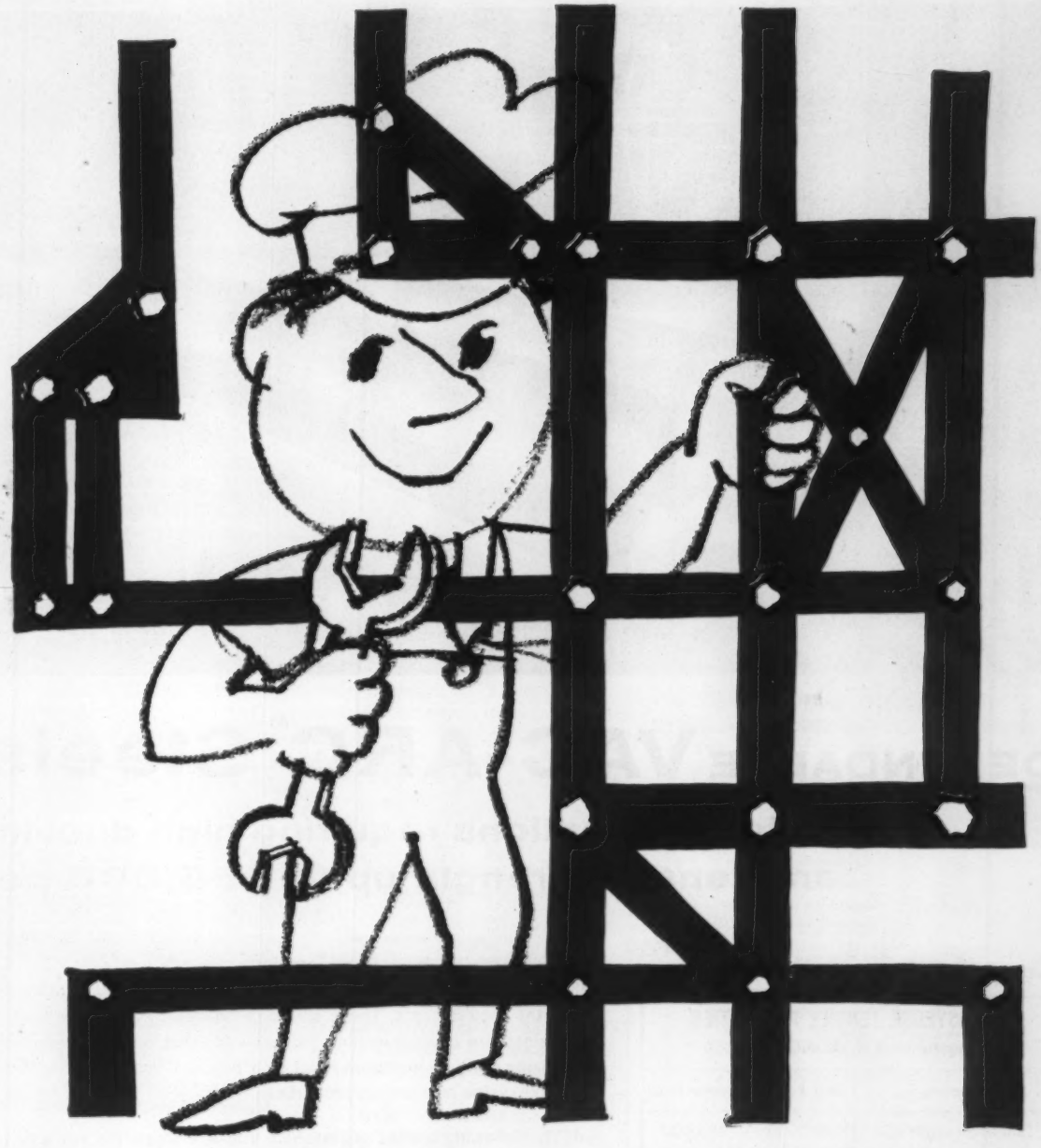
The top and bottom halves of the 12½-in. dia spheres (see accompanying photo) are formed separately in a one-stroke operation. Stamped from 19-in., 22-gage blanks, the sphere halves are drawn to depths of 6.037 and 6.027 in. According to Hoover, "production would be vastly complicated, if not impossible, without the drawing qualities of cold rolled sheet."

Other advantages of cold rolled steel for this application are good surface finish, formability and nonaging characteristics.

***Sphere halves** are drawn in one stroke.*

Jones & Laughlin Steel Corp.

***Completed units** get final inspection.*



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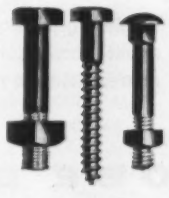

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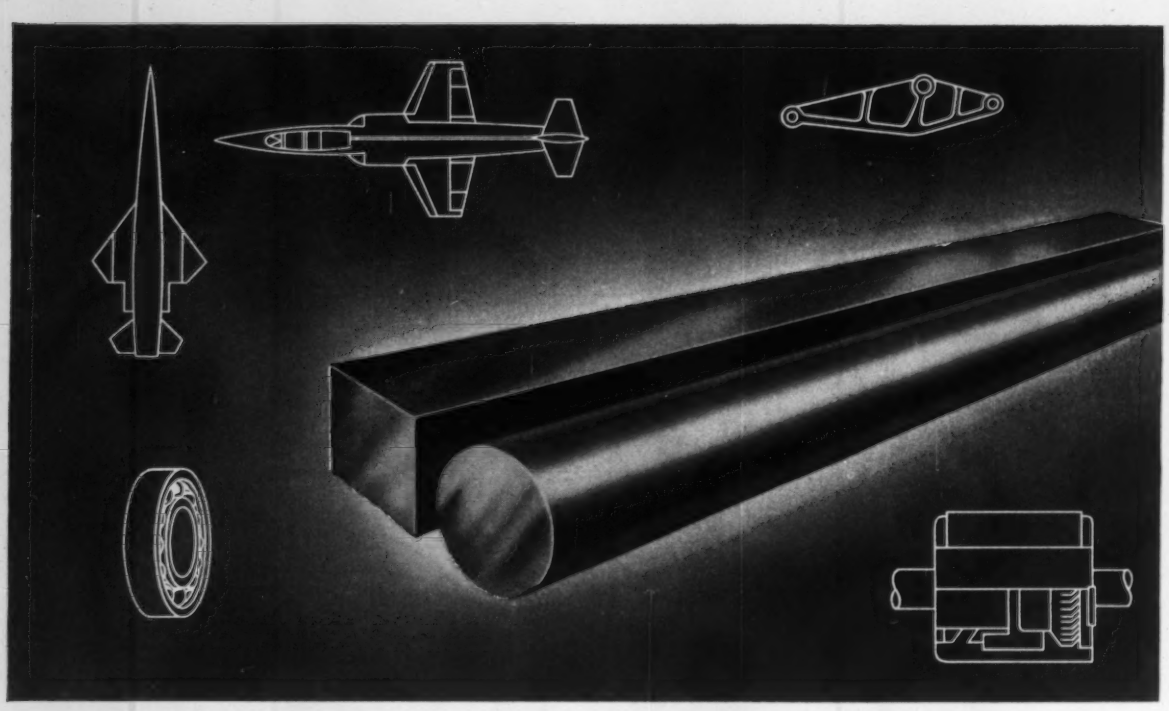

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Reduction of Area %	25	24

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The following grades of Latrobe's Vac-Arc steels are available in a range of sizes and shapes: Pandex (Type A-286) for high temperature applications; MV-1 (Type M-50) and Regent (Type 52100) for critical bearing design; Dynaflex (Type H-11) for aircraft and missile components; AGT (SAE 9310) for carburized aircraft gears.

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continued from p 138

Zinc-Rich Paints: Tests Prove Need for 95% Zinc a Myth

by John R. Fisher, Jr., *Vice President, Industrial Metal Protectives, Inc.*

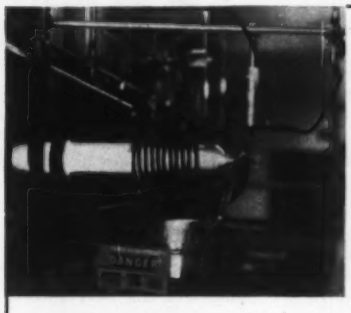
Contrary to common belief, a high concentration of zinc pigment in zinc-rich paints is not necessary to provide good corrosion protection.

Although an excessive amount of metallic zinc (92 to 97%) increases the cost of the coating by as much as 100%, it actually fails to provide protection equal to that of a properly formulated, less costly coating.

Why high zinc content is not necessary

The "95% zinc" fallacy stems from the fact that early zinc-rich paints had to use resin vehicles that were nonreactive. These resins included chlorinated rubber, vinyl and polystyrene, all of which have extremely poor electrical conductivity. Thus, they had to be used with high

Editor's Note: For a complete description of the types and properties of zinc-rich paints, see "Zinc-Rich Paints Protect Iron and Steel Parts," M/DE, July '57, p 102.



Clue to Hydrogen Embrittlement?

The device shown here is being used by scientists at Stanford Research Institute, Menlo Park, Calif. to study the reaction of hydrogen atoms with graphite. The research has yielded a clue which may solve the problem of hydrogen embrittlement.

In the set-up shown above, a radio frequency discharge in the glass tube produces hydrogen atoms from hydrogen molecules. When pressure reaches 20 μ, the hydrogen atoms travel down the tube and impinge on a graphite disk.

The reaction, which takes place at room temperature, has yielded such hydrocarbons as methane, acetylene and higher paraffins. These results have led to the following hypothesis on the mechanism of hydrogen embrittlement:

Hydrogen molecules are dissociated into atoms during absorption, and these atoms are small enough to migrate into steel. Since it has been shown that hydrogen atoms react with carbon at room temperature, SRI assumes that such a reaction can take place in steel. Thus, methane, and possibly other hydrocarbons are formed in the interstitial spaces of steel. The molecules are too big to diffuse further, so they must remain in place, creating tremendous pressures. These pressures, combined with the removal of carbon atoms from the lattice position, cause hydrogen embrittlement, SRI believes.

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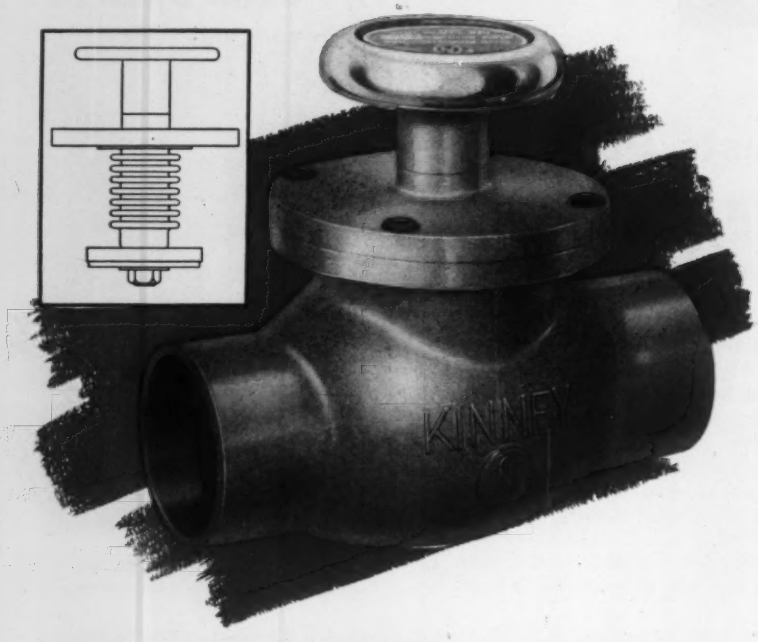

The new Series BBSM KINNEY Vacuum Valves form a reliable force of "Traffic Cops" for your Vacuum systems. In sizes 1", 1½", 2" and 3", these Bronze Bellows Sweat Fitted Valves are especially designed for Vacuum applications having soldered or brazed manifolding. They are of the globe type with non-rising stem, with positive isolation of rotating parts. The brass bellows is sealed to the seat disc and bonnet flange by static "O" rings of Buna N.

Assembly of KINNEY BBSM Valves into the Vacuum system is supremely simple. Removal of stem, cover and bellows assembly as a unit from the body of the Valve is accomplished by unscrewing four cap screws – thus replacement of bellows is no problem. Each KINNEY BBSM Valve is mass spectrometer leak tested to assure vacuum tightness.

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concentrations of zinc to produce maximum electrical conductivity and galvanic protection.

Actually, an excess of zinc loses its effectiveness very quickly. The pigment-binder ratio does not provide a sufficient amount of binder to insulate the zinc from atmospheric attack. The resulting rapid oxidation and formation of zinc carbonate lowers electrical conductivity, thereby reducing the protectiveness of the coating. The low binder content also reduces resistance to high humidity, flexing and impact, and tends to promote chipping and flaking.

As a result of recent research and improved manufacturing it is now possible to use more durable resin vehicles requiring only 75 to 85% metallic zinc for maximum electrical conductivity and galvanic protection.

Tests show superiority of lower zinc content

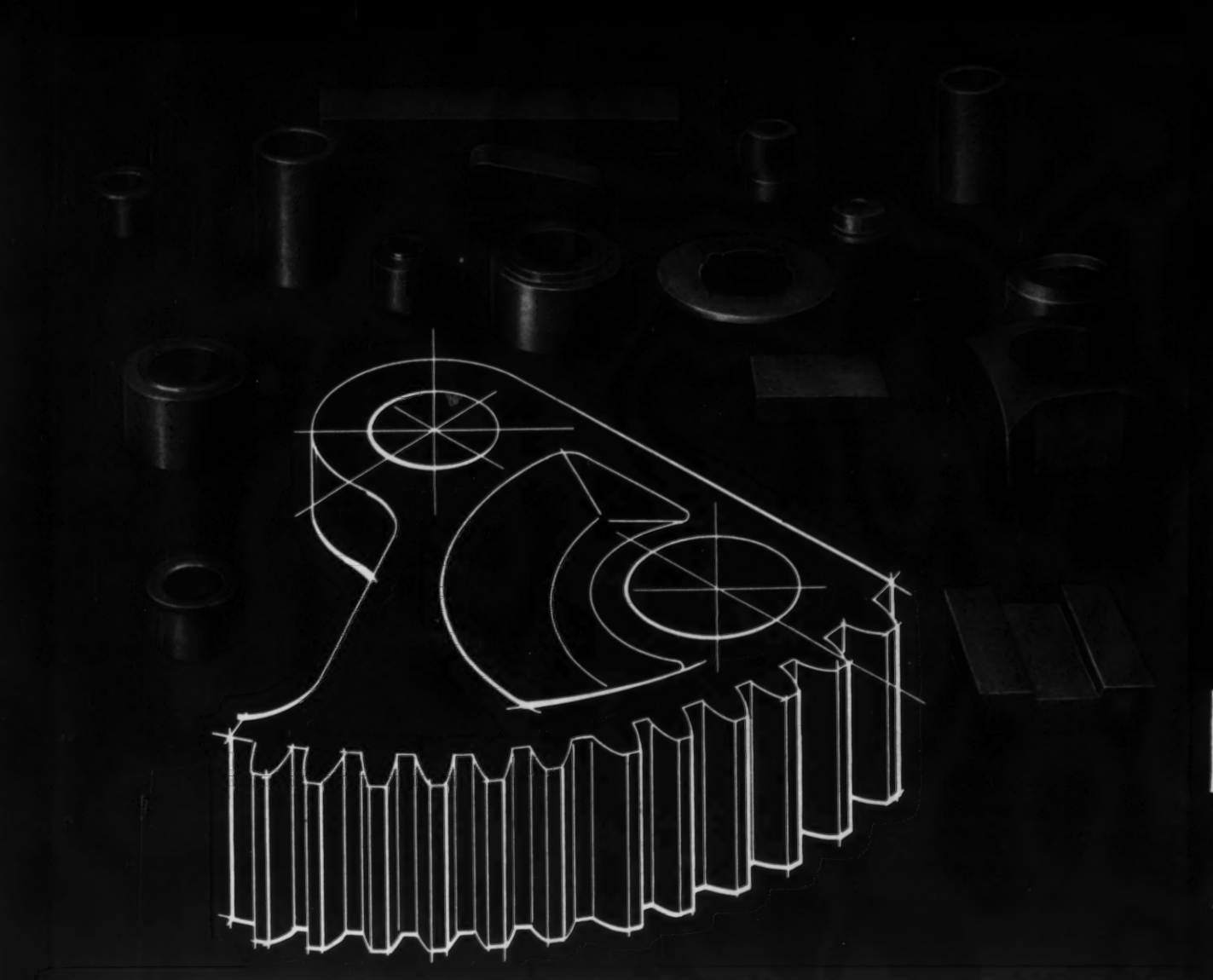
In sea coast exposure tests, panels prepared with coatings of high zinc content in vehicles of chlorinated rubber, styrene and other materials, showed early failure. In contrast, panels with coatings containing 82% zinc have yet to show any signs of failure after 13 years of identical testing. Even after being scribed the panels showed no evidence of corrosion. In fact, the scribed area healed completely, proving that galvanic action was continuous.

In addition to exposure tests, the galvanic protection of zinc-rich coatings can be effectively predicted by measuring coating conductivity. An electrical conductivity test developed by the military pinpoints effective zinc content. These tests show that the more durable resins require only 75 to 85% zinc to produce maximum electrical conductivity and galvanic protection.

How to Print, Form Videne Polyester Film

New information on how to print, tint, coat and form Videne polyester laminating film was given recently by C. W. Taylor of Goodyear Tire & Rubber Co.'s Vitel Products Div., Akron, Ohio.

Videne, introduced in the spring of 1958 (M/DE, May '58, p 141),



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ENGINEERING & DESIGN

is a water-clear, unoriented, amorphous, noncrystallizing thermoplastic material.

Many printing methods suitable

Taylor, who spoke at the 1959 annual meeting of the Rubber and Plastics Div. of the American Society of Mechanical Engineers last December says Videne polyester film can be reverse printed by rotogravure, silk screening, flexagraphic and other printing methods. It can be metallized in conventional vacuum metallizing equipment, and can be pigmented to produce a variety of colors.

The polyester laminating film is compatible with rigid vinyls, papers, metal foils, and metal and wood surfaces, and can be laminated to these materials at temperatures of 250 to 325 F. The film can be embossed immediately after laminating by cold embossing the hot film.

Good for vacuum forming

Taylor says Videne polyester film has excellent vacuum forming characteristics, and will extend to the limits of the substrate material.

ASTM Tests Modified for Synthetic Papers

The use of synthetic fibers in papermaking has necessitated the modification of several existing ASTM and TAPPI (Technical Assn. Paper & Pulp Industry) test methods and the incorporation of new methods to fully characterize these paperlike products.

The tests, described by F. H. Koontz and J. K. Owens in a paper read at the 61st annual meeting of the American Society for Testing Materials, June '59, are:

Tear strength—The tongue tear test (ASTM D39-49) and the Elmen-

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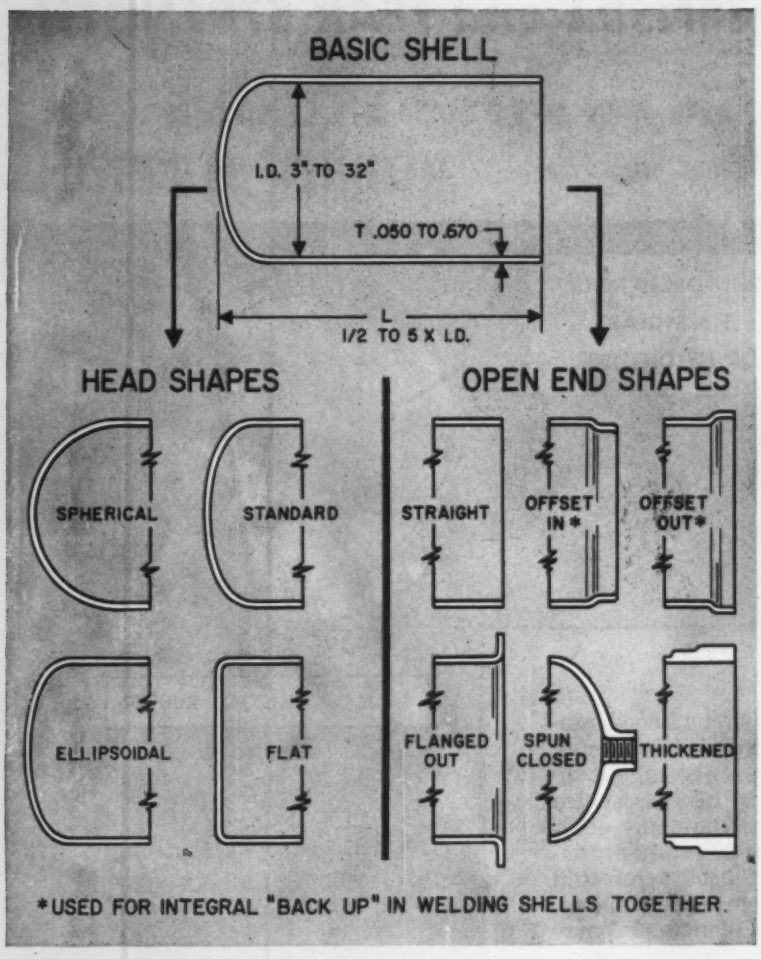

The drawings shown here give you a simple description of the way you can use basic Hackney shells to produce a variety of seamless, lightweight, strong, low-cost rocket motor cases, gas generator housings, control actuator pressure vessels and other missile components.

The basic unit is a cold drawn, deep shell which has uniform wall thickness from top to bottom in ranges from .050″ to .670″. I.D.'s vary from 3″ to 32″. The length of the shell may be from ½ to 5 times the diameter—or up to 110″.

Head shapes—spherical, standard, ellipsoidal, flat or special. *Open end shapes* offer variety—straight cut, offset in, offset out, flanged out, flanged in, spun closed or thickened. *Capacities* begin at 1 quart—go as large as 100 gallons. *Working pressures* range from 100 to 6000 psi, depending upon diameter and wall thickness.

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dorf tear test (ASTM D689-44) may be used to determine tear strength of paperlike products made from synthetic fibers. The tongue tear test has the advantage of producing stress-strain curves that can be used to study the structure of paper.

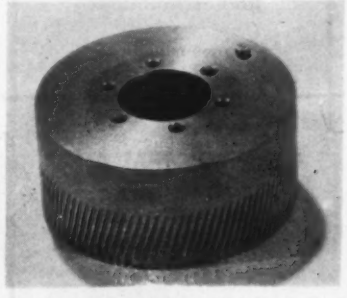
Tensile strength — The short breaking times of existing methods for tensile strength determination of paper should not be used in testing synthetic fiber papers, according to Koontz and Owens. They recommend the use of an extensometer for the determination of elongation and tensile modulus; however, if the device is not available they recommend a 6-in. or longer specimen (i.e., jaw separation).

Chemical resistance—In the absence of a standardized test for the chemical resistance of synthetic fiber papers, Koontz and Owens recommend the ASTM tentative method of test for resistance of plastics to chemical reagents (D543-56T).

Dimensional stability—Moisture sensitivity or dimensional stability of synthetic fiber papers can be determined in accordance with ASTM D1270-53T. This test measures percent increase in length occurring with a 35% increase, from 15 to 50%, in relative humidity.

Microstructure Affects Wear of Bronze Gears

Variations in the wear resistance of sand cast, leaded tin bronze gears used in a radar system prompted D. K. Fox of Westinghouse Electric Corp. to find the cause of this abnormal behavior. Preliminary tests



***Sand cast** leaded tin bronze helical gear used in a radar system.*

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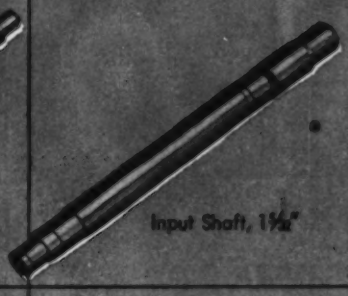
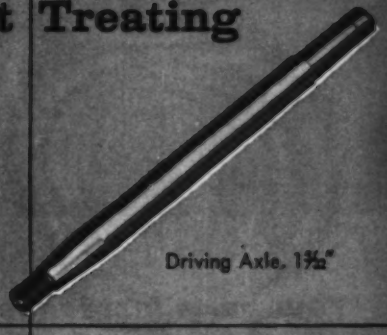
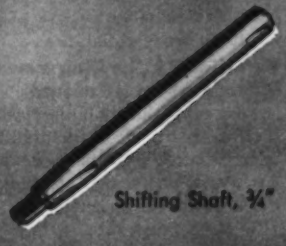
Worm Shaft, 1½"


Input Shaft, 1½"


Driving Axle, 1¾"


Shifting Shaft, ¾"

Reverse Pinion, 3"

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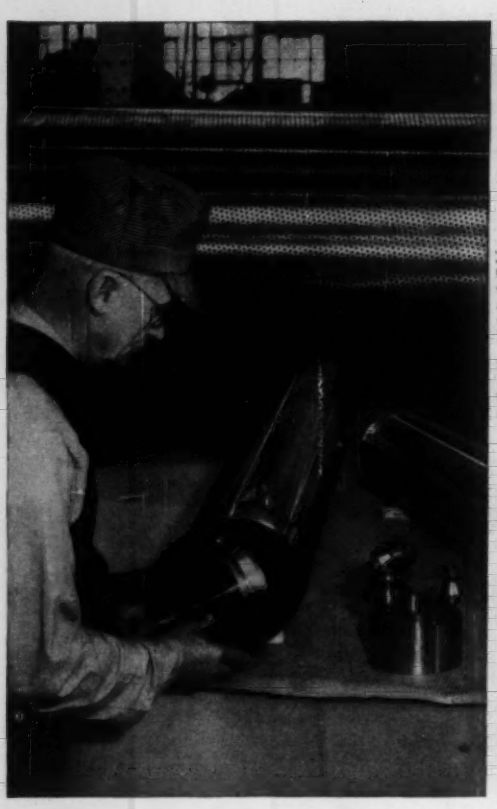

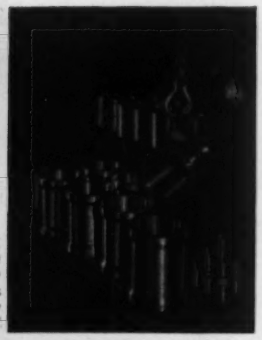

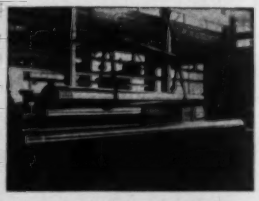

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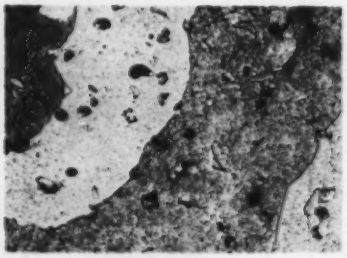
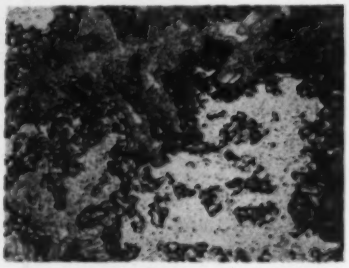


Acceptable casting *as it appears under the microscope (500X).*



Defective casting *as it appears under the microscope (500X).*

at the company's Materials Laboratories in East Pittsburgh, Pa. showed that microstructure had a decided effect on wear resistance.

Variations in cooling cause differences in structure

Fox says that microscopic examination revealed a wide difference in structure between a gear rated acceptable and a gear rated defective by wear tests. Specifically:

1. Most gears rated defective were severely cored and contained brittle constituents in the grain boundaries. This condition is usually caused by extremely fast cooling of the casting through the solidification temperature range, according to Fox.

2. Gears rated acceptable were less severely cored and tended to be homogeneous. This condition is predominant in sand castings that cool at a relatively slow rate through the solidification temperature range.

Annealing improves wear resistance

Fox says a successful way to overcome these microscopic differences is to anneal the casting for 24 hr at 930 F, then water quench. According to Fox, this annealing treatment results in a marked homo-

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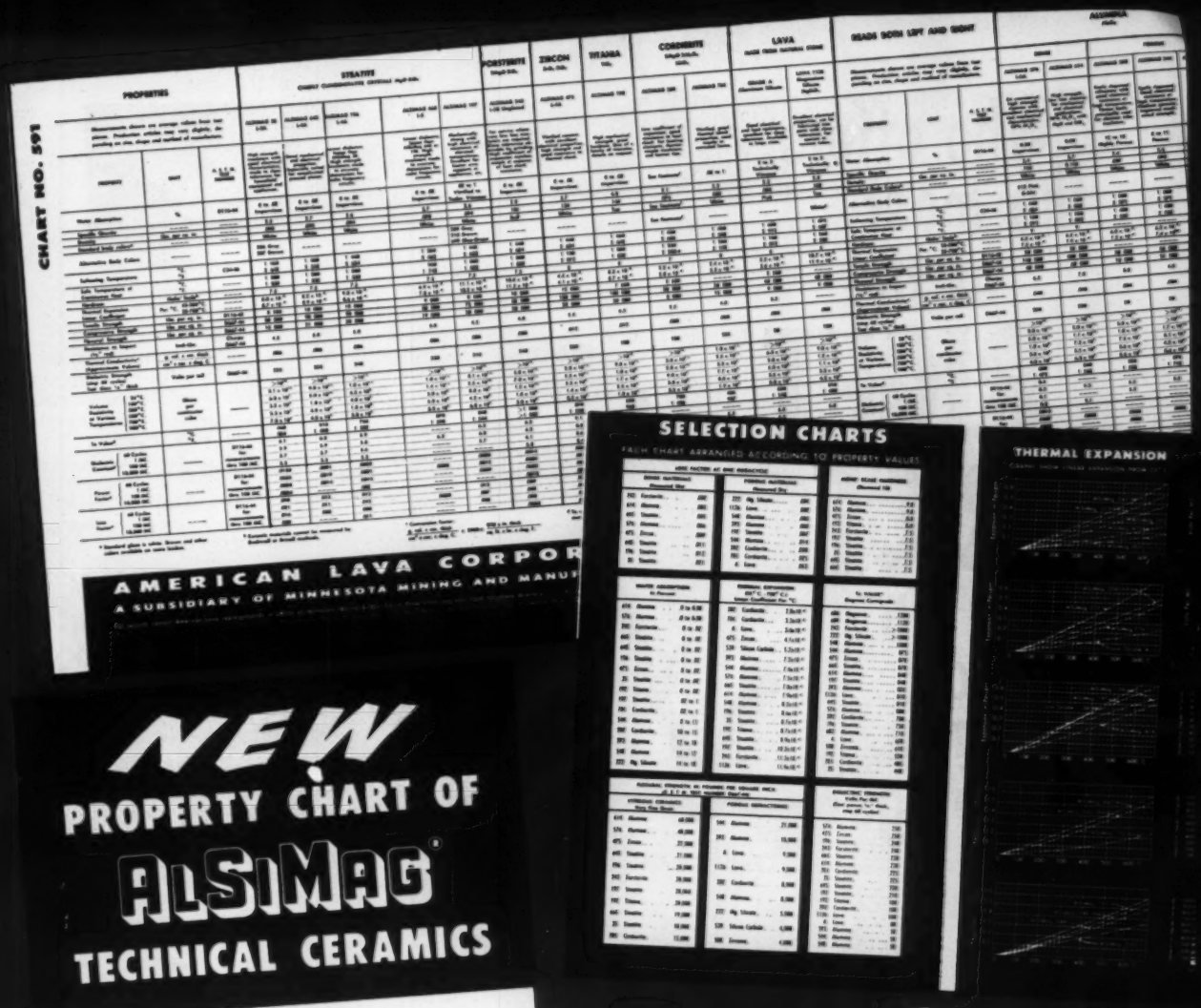

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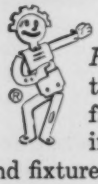

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genization of a defective gear.

Other methods

Another way to minimize microscopic differences in cast, leaded tin bronze gears is to use the centrifugal casting process with controlled cooling instead of sand casting.

This method produces cast gears with good grain size, microstructural uniformity, and improved properties. Tests show the centrifugally cast gears have good wear resistance.

Powder metallurgy techniques also show promise of producing good leaded tin bronze helical gears.

Oxygen Needed for Good Magnetic Alloys

Present research on magnetic annealing at Bell Telephone Laboratories, 463 West St., New York 14 shows that more uniform magnetic alloys can be obtained by closely controlling the oxygen content of the alloys.

The research, conducted by R. D. Heidenreich, R. D. Burbank and E. A. Nesbitt, is aimed at solving the mystery of magnetic annealing. The generally accepted theory for magnetic annealing is based on the short range ordering of metal atoms in a magnetic alloy.

Oxygen content important

Work at Bell Laboratories indicates that soft magnetic alloys of nickel-iron (Permalloy) and nickel-cobalt-iron (Perminvar) fail to respond to magnetic annealing (heat treatment in a strong magnetic field) when oxygen content of the alloys is lower than 14 ppm.

The research shows that magnetic strength of the alloys varies little at oxygen contents between 14 and 20 ppm. However, substantially greater amounts of oxygen may cause oxide formation in the alloys.

Role of oxygen in magnetic annealing

Although the mechanism by which oxygen causes this effect is not yet fully understood, Heidenreich and his associates theorize that the oxygen atoms deposit on the stacking plane of the crystal at certain elevated temperatures, resulting in a displacement or dislocation of the

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next plane of atoms. When enough of these oxygen atoms are present, the alloy can be magnetically oriented by field heat treatment.

Status of Aluminum Powder Metallurgy

The powder metallurgy of aluminum and aluminum alloys for the most part is still in its infancy, according to J. D. Shaw and W. V. Knopp of S-K-C Research Asso., 445 5th Ave., Paterson 4, N. J.

Reason: aluminum has a low melting point (1220 F) which makes it applicable to processes competitive with powder metallurgy techniques, such as die casting.

Then too, aluminum powders tend to "cold weld" or adhere to steel surfaces with which they come in contact. This interferes with the formation and ejection of the compact. In addition, the presence of hard, abrasive aluminum oxide on the surface of the powders tends to score the surfaces of even the hardest die material, destroying the finish of the die.

These factors are said to be major deterrents in the production of alumin powder parts.

Need for better lubricants, coarser powders

Shaw and Knopp suggest possible areas where aluminum powder metallurgy techniques might be improved:

Lubricants: develop a suitable lubricant or method for applying a lubricant to the walls of dies in automatic compacting presses.

Die lubricants such as suspensions of fatty acids, metallic soaps and oils can be used. But these lubricants are difficult to place on die walls and dry out between each operating cycle of an automatic press.

Powders: develop coarser powders with good molding characteristics. Aluminum powders of relatively coarse size (60 to 100 mesh) have much less surface area and much less surface oxide than fine powders. With such powders, lubricants are not erased so quickly from the die, and the die remains lubricated during pressing and ejection.

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TECHNICAL LITERATURE

(cont'd from p 53)

Books

Marine Design Manual for Fiberglass Reinforced Plastics. *Prepared by engineers of Gibbs & Cox, Inc. McGraw-Hill Book Co., Inc., New York. 1960. Cloth, 8½ by 11 in., 400 pp. Price $15*

This book gives sound engineering and design practices for the construction of fiberglass boats and other large structures. Subjects of the six chapters are: physical and mechanical properties of fiberglass laminates; behavior of laminates under load; molding methods; use of polyester and epoxy resins, inhibitors, catalysts and accelerators in fiberglass laminates; and methods, formulas and approaches to the design of both isotropic and orthotropic laminates in tension, compression and flexure.

The book is well illustrated with photographs, tables and graphs.

Acrylic Resins. *M. B. Horn. Reinhold Publishing Corp., New York. 1960. Cloth, 5 by 7½ in., 190 pp. Price $4.50*

Discusses the chemistry of acrylic monomers and polymers, and the manufacture, properties, fabrication and uses of cast acrylics. The book also gives information on acrylic molding powders, emulsions and solution polymers.

Materials and Techniques for Electron Tubes. *W. H. Kohl. Reinhold Publishing Corp., New York. 1960. Cloth, 6 by 9 in., 658 pp. Price $16.50*

Discusses composition, properties and behavior of materials used in electron tubes. The book also gives information on methods for joining electron tube materials, such as brazing of metals, glass-to-metal sealing, and ceramic-to-metal sealing.

Progress in Non-Destructive Testing: Vol. 1. *Edited by E. G. Stanford and J. H. Fearon. Macmillan Co., New York. 1959. Cloth, 6 by 10 in., 274 pp. Price $12*

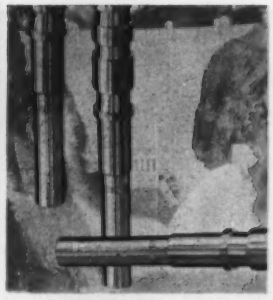
The various papers deal with 1) recent developments in industrial radiography; 2) fluoroscopy and screen intensification processes; 3) stress wave propagation as applied to the detection of flaws by ultrasonic inpection; 4) electromagnetic methods of testing metals; 5) neutron radiography; 6) medical aspects of nondestructive testing; 7) thermal conductivity as a nondestructive testing technique; 8) use of damping capacity for investigating the structure of solids; and 9) use of nuclear magnetic resonance for testing materials.

The present volume is the first of an annual series of reviews on progress in nondestructive testing.

1958 Minerals Yearbook: Metals and Minerals—Volume 1. *Prepared by the staff of the Bureau of Mines, Div. of Minerals. Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 1959. Cloth, 6 by 9 in., 1238 pp. Price $4*

Cemented Carbides. *P. Schwarzkopf and R. Kieffer. Macmillan Co., New York. 1960. Cloth, 6½ by 9½ in., 355 pp. Price $15*

Gives mechanical and chemical properties



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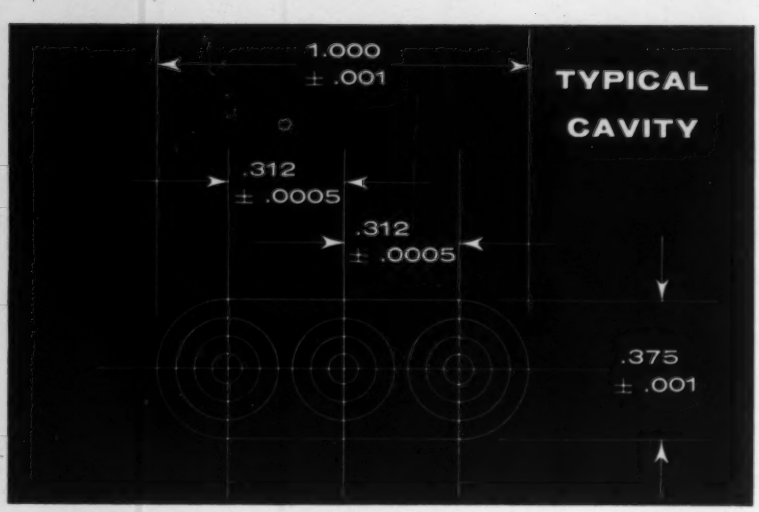

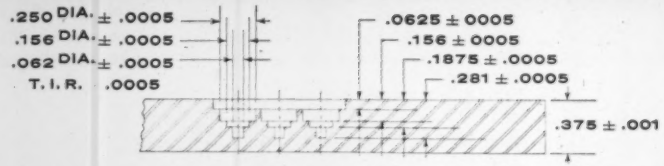

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TECHNICAL LITERATURE

of all cemented carbides in commercial production and those that are being produced in experimental quantities. Of special interest is a chapter on new oxide and boride cutting materials. The book also gives information on the use of cemented carbides as drawing dies, drilling and cutting tools, bullet cores, and wear resistant parts.

1959 Compilation of ASTM Standards on Copper and Copper Alloys—B-5. *American Society for Testing Materials, Philadelphia. 1960. Cloth, 6 by 9 in., 720 pp. Price $7.50*

Contains 137 standards of which 17 are new, revised or have had their status changed since the previous edition in 1957. The standards include methods of test, definitions, specifications, classifications, and recommended practices applicable to copper and copper alloys, filler material, pipe, tubes, wire, rod, bar, shapes, die forgings, plate, sheet, strip and rolled bar.

Metal Castings Buyers Directory: 1959-1961 Edition. *American Foundrymen's Society, Des Plaines, Ill. 1959. Cloth, 8½ by 11½ in., 329 pp. Price $10*

Theory of Mechanical Vibration. *Kin N. Tong. John Wiley & Sons, Inc., New York. 1960. Cloth, 6 by 9 in., 360 pp. Price $9.75*

Digest of Literature on Dielectrics, Volume 22. *National Academy of Sciences, National Research Council, Washington, D. C. 1959. Publication No. 713. Paper, 8½ by 11 in., 300 pp. Price $5*

Digest of literature published during 1958 on dielectrics and dielectric phenomena. Information is given on instrumentation and measurements; rubber and plastics insulating materials; ferroelectric, piezoelectric and ferromagnetic materials; insulating films; ceramic insulation; and insulating liquids.

Kinetics of High Temperature Processes. *Edited by W. D. Kingery. John Wiley & Sons, Inc., New York. 1959. Cloth, 8 by 10 in., 342 pp. Price $13.50*

Subjects of the various papers given in this book include: 1) imperfections and diffusion in nonmetallics; 2) diffusion in liquids and liquid-solid reactions; 3) nucleation and grain growth; 4) sintering and vitrification; 5) phase transformations; and 6) solid and solid-gas reactions.

Nuclear Fuel Elements. *Edited by H. H. Hausner and J. F. Schumar. Reinhold Publishing Corp., New York. 1959. Cloth, 6 by 9 in., 420 pp. Price $12.50*

Discusses metallic fuel elements made from uranium, thorium and plutonium; dispersion-type fuel elements; high temperature fuel elements; and the behavior of fuel elements under reactor operating conditions. Contains typical specifications for nuclear fuel elements, and a bibliography of 494 references.

How to Design and Buy Investment Castings. *Investment Casting Institute, Chicago. 1959. Cloth, 6 by 9 in., 176 pp. Price $3.95*

Discusses the investment casting process, choice of alloys, vacuum metallurgy, and design and quality of investment castings. The book tells how to buy investment castings, and gives ICI (Investment Casting Institute) specifications for casting alloys.

Symposium on Electroless Nickel Plating. *ASTM Special Technical Publication No. 265. American Society for Testing Materials, Philadelphia. 1960. Cloth, 6 by 9 in., 70 pp. Price $2.50*

The nine papers given in this book are: history of electroless plating; chemical reactions; characteristics of deposits; processing procedures; advantages and limitations; applications; test methods for electroless nickel

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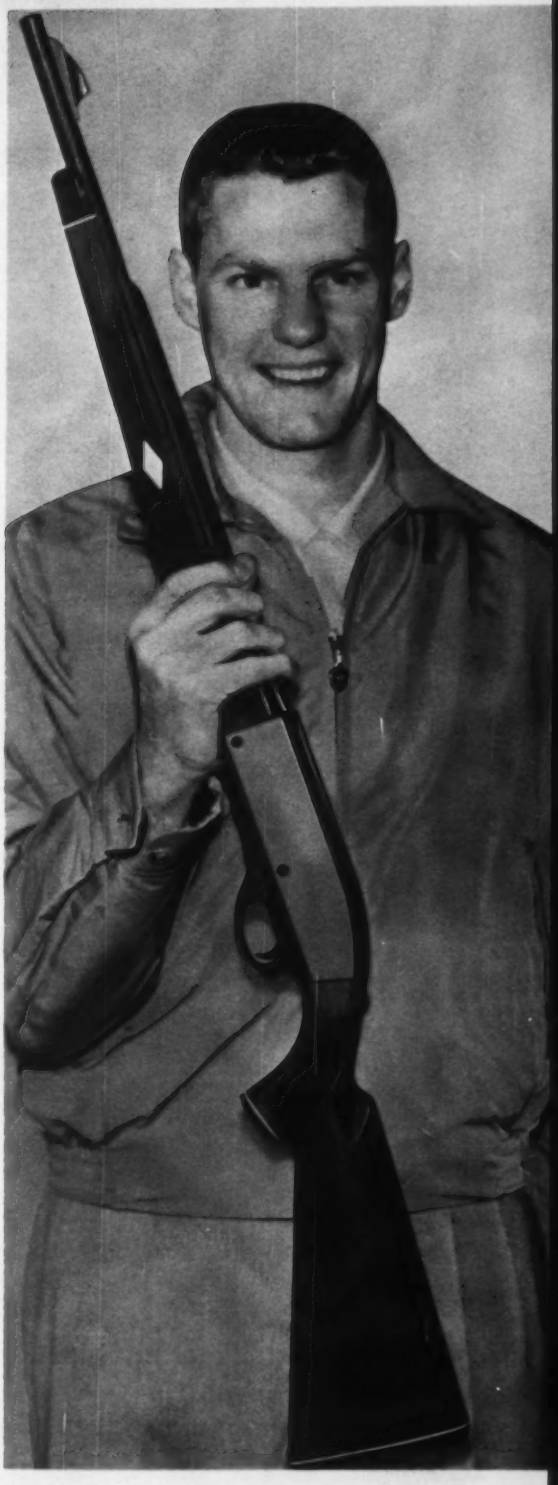

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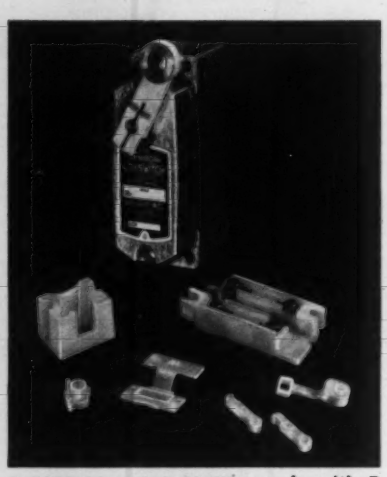

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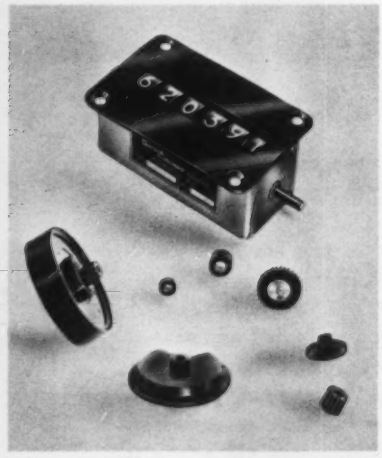
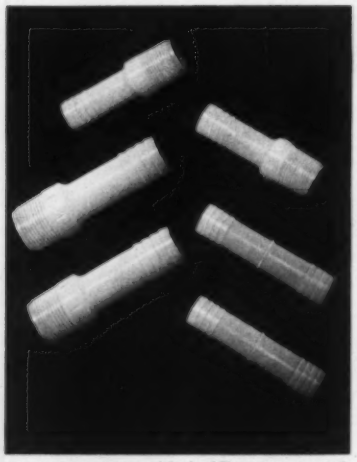


COUNTER for instruments such as clocks and high-speed money counter uses drums, gears and other components molded of ZYTEL. Reasons: ZYTEL can be molded to close tolerances, and it offers the abrasion resistance and high fatigue endurance required for long, trouble-free service. (Molded by B & B Plastics, Inc., Oakville, Connecticut, for Haydon Instrument Company, Waterbury, Connecticut.)



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coating and plating solutions; patents; and bibliography of references on electroless nickel plating.

An Introduction to the Mechanics of Solids. *Edited by S. H. Crandall and N. C. Dahl. McGraw-Hill Book Co., Inc., New York. 1959. Cloth, 6 by 9 in., 454 pp. Price $8.50*

Information on mechanics of deformable bodies, forces and moments transmitted by slender members, stress and strain, stress-strain temperature relations, torsion, stresses and deflections due to bending, and stability of equilibrium.

Isotope Index: 4th Edition. *Scientific Equipment Co., P. O. Box 19086, Indianapolis 19, Ind. 1960. Price $5*

List of companies supplying stable and radioactive isotopes.

Reports

Honeycomb sandwich design HONEYCOMB SANDWICH DESIGN. *1959. 45 pp. Hexcel Products, Inc., 2332 4th St., Berkeley, Calif. Price 50¢ (No. E)*

Summary of sandwich design methods complete with formulas and "worked-out" examples for stress computations on typical sandwich structures.

Magnetostriction in cobalt MAGNETOSTRICTION IN COBALT AND COBALT ALLOYS. *1960. 60 pp. Cobalt Information Center, c/o Battelle Memorial Inst., 505 King Ave., Columbus 1, Ohio.*

More than 125 references to magnetostriction effects in cobalt and cobalt alloys are listed, covering technical literature from 1874 through mid-1959. These references are accompanied by informative abstracts and tables. Forty-eight figures provide additional data.

Properties of polyethylene PROPERTIES OF POLYETHYLENE AND RELATED POLYMERS. *C. Heller, S. Levinson and C. Nudelman, TRG, Inc. Apr '57. 54 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1.50 (PB 151584)*

Properties of polyethylene, polystyrene, polyisobutylene and polymethylene, with emphasis on their use in radiation shielding.

Urethane cushioning MATERIALS, TECHNIQUES, AND ECONOMICS OF FOAMED-IN-PLACE POLYURETHANE CUSHIONING FOR PACKAGING. *S. Childers, Wright Air Development Center. Apr '59. 35 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1 (PB 151831)*

Discusses chemistry and aging characteristics of polyurethane foams, and foaming methods.

Research RESEARCH HIGHLIGHTS OF THE NATIONAL BUREAU OF STANDARDS: ANNUAL REPORT 1959. *169 pp. 1959. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 55¢ (NBS Publication No. 229)*

Gives information on a wide range of scientific studies performed on heat resistant materials, high purity nickel, aluminum, organic and fibrous materials, brass and titanium. Also, the refinement of atomic stand-

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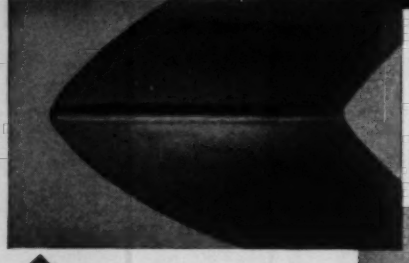
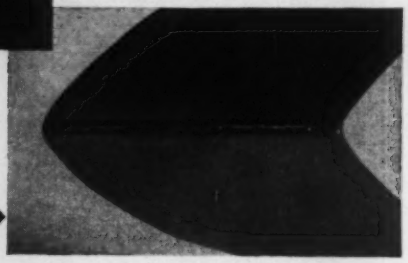


These photos will give you an idea of how Waterbury Rolling Mills *precision-annealed* phosphor bronze can improve your production.



Close up shows how WRM *precision-annealed* spring temper phosphor bronze withstands severe bend.

Close up of ordinary-annealed spring temper phosphor bronze shows surface beginning to rupture at the bend.

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TECHNICAL LITERATURE

ards of length and frequency, establishment of a vibration pickup calibration service, and special measurements of the heat conductivity of explosives and solid propellants.

Steel castings specifications BRITISH AND FOREIGN SPECIFICATIONS FOR STEEL CASTINGS: PART I. *62 pp. 1959. British Steel Castings Research Assn., East Bank Rd., Sheffield 2, England. Price $7.50*

Technical publications INDEX OF NACA TECHNICAL PUBLICATIONS: JULY, 1957 TO SEPTEMBER, 1958. *National Aeronautics and Space Administration, Washington, D. C. 1959. 345 pp.*

Gives chronological list of NACA (National Aeronautics and Space Administration) reports under subject classification; list of reports declassified from July '57 through Sept. '58; alphabetical index to subject categories; and author index.

Engineering filing systems BIBLIOGRAPHY ON FILING, CLASSIFICATION, AND INDEXING SYSTEMS FOR ENGINEERING OFFICES AND LIBRARIES. *33 pp. 1960. Engineering Societies Library, 29 W. 39th St., New York 18. Price $2 (No. 14)*

Selected list of references to books, pamphlets and magazine articles on filing, classification and indexing. Information on hand-sorted punched card systems suitable for organizing small collections of engineering books, notes, correspondence, abstracts, reprints and manufacturers' literature.

Plastics industry PLASTICS: THE STORY OF AN INDUSTRY. *Society of the Plastics Industry, Inc., 250 Park Ave., New York 17. 44 pp. Price 30¢*

Presents a brief overall picture of the entire plastics industry, touching on its history, development, types of companies involved, types of plastics, manufacturing processes, and products made by them.

Magnetism vs temperature THE EFFECT OF TEMPERATURE ON THE MAGNETIC PROPERTIES OF SILICON-IRON, COBALT-IRON AND ALUMINUM-IRON ALLOYS. *J. J. Clark and J. F. Fritz, Westinghouse Electric Corp. July '59. 37 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1.50 (PB 161078)*

Normal magnetization curves at various temperatures, normal permeability versus magnetizing force, coercive force and residual induction vs temperature, and total core loss at various inductions vs temperature for silicon-iron, cobalt-iron and aluminum-iron alloys.

High temperature resistor RESISTORS, FIXED, ULTRA-HIGH TEMPERATURE, RADIATION RESISTANT. *D. R. Silvertsen, P. R. Mallory & Co., Inc. July '59. 47 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1.25 (PB 161081)*

Describes a 1-w resistor capable of operating at extreme temperatures in nuclear radiation environments.

Hot wire insulation *Office of Technical Services, Dept. of Commerce, Washington 25, D. C.*

Two reports on progress in developing a wire insulation capable of withstanding temperatures up to 1500 F.

HIGH-TEMPERATURE INSULATION FOR WIRE: PART 2. *J. N. Harris and J. D. Walton, Georgia Inst. of Technology. July '59. 40 pp. Price $1.25 (PB 151944)*

HIGH-TEMPERATURE ELECTRICAL INSULATING INORGANIC COATINGS ON WIRE: PART 2. *C. G. Bergeron and others, University of Illinois. June '59. 55 pp. Price $1.50 (PB 151948)*

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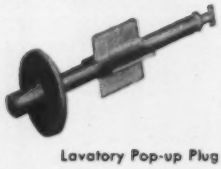
Lavatory Pop-up Plug

For more information, turn to Reader Service card, circle No. 448

cont'd from p 81

One-Coat Enameling Covered at Symposium

Several interesting developments in one-coat enameling — including three new processes and a new inexpensive sheet material—were discussed at the recent 21st annual Shop Practice Forum of the Porcelain Enamel Institute.

Technical details will be published in the June issue of M/DE.

Special Courses Cover Engineering Materials

Here is another report on special courses on engineering materials being offered by leading universities and colleges:

Pennsylvania State University—*Electrical Contacts (June 5-10):* theory and practice in electrical contacts, with emphasis on instrument and control contacts.

Ohio State University—*Principles of Welding Engineering (June 13-24):* designed to provide training equally applicable to the structural, piping, pressure vessel, nuclear, aircraft, automotive and many other fields. Will cover such things as properties of materials, metallurgy of steels and nonferrous metals, welding of steels and nonferrous metals, brazing and soldering, filler metals, distortion and residual stresses, testing of welds, welding design, new techniques, and practically all of the better known welding methods.

Massachusetts Institute of Technology—*Strength of Plastics and Glass (June 20-24):* an examination of the similarities that appear to exist between polymeric materials and glass insofar as strength and fracture are concerned. Specific topics include: fracture mechanisms; effects of time, temperature and composition; and effects of environment and physical state. *Fundamentals of Adhesion (June 27-July 1):* physical, chemical, rheological and mechanical considerations in the choice of adhesive materials. Topics to be covered include solid surfaces, removal of weak boundary layers, wetting, ap-

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MAKE A GOOD PRODUCT BETTER

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Our report to the client specified newer, lighter materials, sound deadening, and appealing colors. Retest of the improved model warranted production go-ahead.

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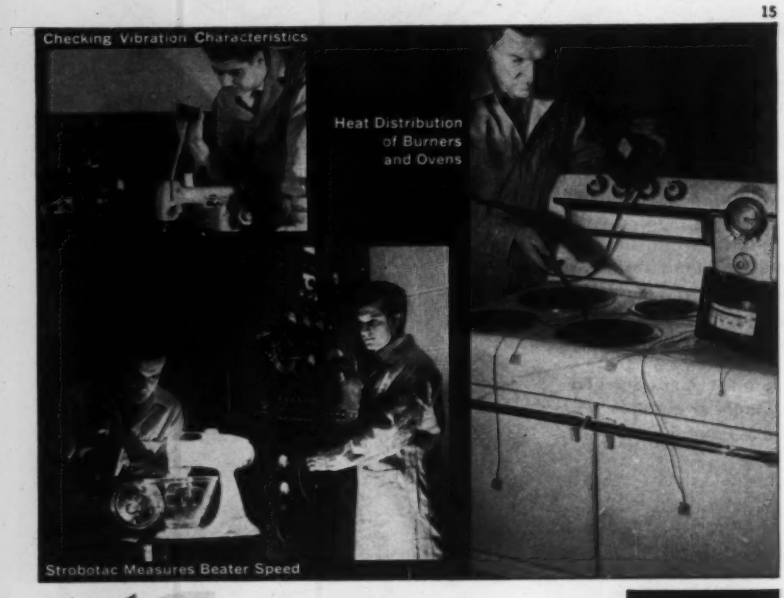

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For more information, turn to Reader Service card, circle No. 340

plication of adhesives, tackiness, setting of adhesives, physical and chemical changes during setting, strength of joints, stress concentrations, and theory of adhesive joints.

Previously announced

New York University—Vacuum Metallurgy (June 2-3).

Pennsylvania State University—Machinability (June 6-10); Design Engineering (June 12-17).

Boston College—Industrial Spectrography (July 18-29).

Massachusetts Institute of Technology—Solidification of Metals (Aug 22-26).

AIME to Meet on High Speed Forming

"New Developments in Metalworking" will be the theme of the 14th New England Regional Conference sponsored by the Connecticut, Boston, Hudson-Mohawk Section of the American Institute of Mining, Metallurgical and Petroleum Engineers.

The Conference, set for May 26-27 at the Hotel Statler in Boston, will consist of three sessions: high speed forming, extrusion, and special forming processes. Each session will be prefaced by a review of the theory involved. Following is a brief rundown of specific subjects to be covered:

High speed forming: explosive forming, explosives for forming, and application of high energy rates to manufacturing techniques.

Extrusion: composite extrusions, extrusion of metal powders, and precision cold extrusion.

Special metalworking processes: looking ahead in forging, fabricating processes to obtain special properties, shear spinning, and future metal processing problems.

A number of special exhibits and a plant tour have also been planned.

SOURCES of most engineering materials can be found in the third edition of M/DE's *Materials Selector* reference issue, published last October. Properties of all materials are also given.

Tool Steel Topics

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Fabricator Reduces Punching Costs by Changing to Omega Tool Steel

This picture, taken at Dave Steel Co., Asheville, N. C., shows Bethlehem Omega tool steel punching a ½-in. diam hole in a structural angle about ⅜-in. thick. The fabricator reported that the Omega performed as though the structural steel were so much butter. It produced thousands of clean, burr-free holes of uniform size, resulting in an 18 pct reduction in punching costs, as compared with the grade formerly used.

Omega is our "super" grade of oil-hardening, shock-resisting tool steel. In addition to being a long-wearing grade, Omega offers maximum shock-resistance for hardnesses up to Rockwell C-59.

Omega tool steel can be quenched in oil at 1625 F. It also offers the advantage of water quenching from 1550 F.

TYPICAL ANALYSIS

C	Mn	Si	Mo	V
0.60	0.70	1.85	0.45	0.20

Besides its use in punches, Omega is also ideal for calking tools, beading tools, shear blades and chipping chisels—in fact, any severe service involving drastic and repeated impact.

If you would like full details on Omega tool steel, get in touch with your Bethlehem tool steel distributor.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Pack Hardening Tools? Be Sure to Use a Thermocouple

When pack hardening tools to reduce scaling and decarburization, it's a good idea to place a thermocouple in the pack, against the tools, to check accurately the time the tools are at heat. Failure to do so may lead to trouble.

For example, an experienced heat-treater pack hardened a large-diameter die ring made of Bethlehem Lehigh H tool steel. Then he checked the hardness. Imagine his surprise to find it was only Rockwell C-48. Puzzled, he checked the furnace pyrometer charts. They showed that the recommended heating cycle had been followed. But why such a low hardness?

A Bethlehem contact metallurgist suggested that the die ring be rehardened, and that a thermocouple be inserted in the pack against the ring. After this was done, and the cycle repeated, the hardness jumped to Rockwell C-60. It was noted that the time required to heat the tool was 50 pct greater than in the first cycle. Thus the heat-treater had proof that in the initial treatment, the die ring was not heated long enough to reach proper temperature, despite the fact that the furnace pyrometer apparently indicated the correct heating cycle.

Upset-forged Discs Are Easy To Machine

Bethlehem upset-forged discs, made of Cromo-WV (H-12) tool steel, are ideal for aluminum extrusions tooling because of the basic 5 pct chrome analysis. They are also economical because of their easy machinability, and ease of heat-treatment. They're made with exacting care, and are finished in ring dies to insure good section and sharp edges. Moreover, Cromo-WV has good resistance to washing and heat checking.

For more information, turn to Reader Service card, circle No. 416

HIGH DENSITY
POLYETHYLENE
PROFIT PARADE

New Plastic Cooling Tower Grids Last Longer—Cool Better

Are you working on a new way to improve the performance of your products? Grex high density polyethylene could be the best material for your application, just as it is for the superior cooling tower grids developed by Fluor Products Company.

Fluor "Poly-Grid" takes the place of a wooden egg crate construction in film-type tower packing. As water cascades through this type of packing it is broken into a continuous film to permit evaporation and cooling. Efficiency is improved by increasing the surface area of the packing with thinner strips and more spaces between them. This principle is applied by "Poly-Grid" to provide more cooling per cubic foot than any other packing.

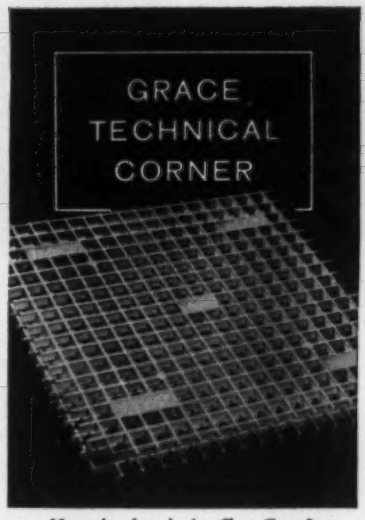
The grids molded of Grex are designed for use in water cooling systems contaminated by chemicals. This Grace plastic is impervious to corrosive action of most chemicals. The grids utilize the strength and rigidity of Grex in moldings that cover an area of up to 9 square feet. They are light in weight. Compared to wooden tower packing, they require far less maintenance and are much more durable. As Fluor engineers put it, "Poly-Grid" can be considered to have a longer service life than any other cooling tower fill material now in use.

Find out more about high density polyethylene for improved products in your field by calling in the experts. Grace has the production facilities, technical service and experience to help put your products in the Grex profit parade. Everyone says we're easy to do business with.

Grex is the trademark for W. R. Grace & Co.'s Polyolefins.

W.R. GRACE & CO.
POLYMER CHEMICALS DIVISION CLIFTON, NEW JERSEY

For more information, turn to Reader Service card, circle No. 506



How do chemicals affect Grex?

From the standpoint of resistance to chemical attack, high density polyethylene is perhaps the most versatile plastic available today for consumer and industrial products. Grex withstands staining, embrittlement, permeation, softening and distortion when exposed to many different liquids and gases normally harmful to other materials. A key reason why Fluor chose Grex for "Poly-Grid" is the fact that it cannot be damaged by such chemicals as hydrocarbons present in industrial water cooling systems. Similar problems have been solved for a wide range of other products by specifying this plastic. Here are a few examples.

Industrial chemicals. Five-gallon carboys for shipment of virtually all corrosive alkalies and acids are made of high density polyethylene.

Agricultural chemicals. A fertilizer spreader for home gardeners and a fitting for an agricultural sprayer are made of Grex to withstand attack of agricultural chemicals.

Salt water. Marine rope, a fishing tackle box and a marine battery case are made of high density polyethylene to withstand harmful effects of sodium chloride and other chemicals in salt water.

Petroleum products. A jerry can blow molded of high density polyethylene is unaffected by most petroleum products.

Chlorine. The valve for a home swimming pool chlorine pump utilizes Grex to resist corrosion.

Get more details. Send for the new Grace Technical Service Bulletin, No. 104, "Chemical Resistance of Grex." And remember that Grace is ready and willing to provide technical assistance for your high density polyethylene projects. Bring us into your picture soon.

Technical Service Department
W. R. Grace & Co., Clifton, N. J.

(cont'd from p 20)

New Glasses Pass Infrared, Conduct Electricity, Absorb Water

Corning Glass Works, Corning, N. Y. has introduced a variety of new glass products. They are 1) a new glass with good infrared transmission characteristics, 2) two new glasses designed for use as the dielectric material in electroluminescent devices, 3) moisture-absorbing glass disks, and 4) a line of clear sealing glasses.

1. Infrared transmission glass

Code 9752 is the name given to Corning's new infrared transmission glass. It is designed for use in guided missiles and optical instruments.

A 2-μ thickness of the glass will transmit 77% of the infrared at a 4.0-μ wavelength and 38% at a 5.5-μ wavelength. The developer says the glass has no transmission loss at 4.0μ and only 13% transmission loss at 5.5μ when exposed to a temperature of 1100 F.

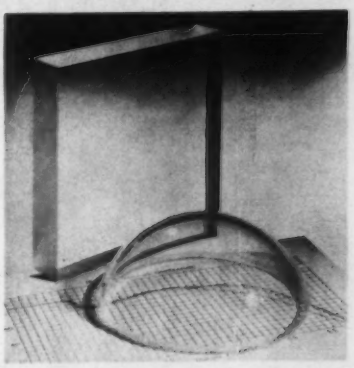
The glass is said to have good electrical properties and excellent weathering characteristics. In a durability test, no appreciable transmittance loss was found in 24 days at 95% RH with temperature cycling twice daily between 77 and 150 F.

The glass is available in hollow shapes and flat pieces. Domes 7 in. in dia (see photo) can be automatically pressed, and larger sizes can be made on order. KEY NO. 613

2. Electroluminescent glasses

The two new electroluminescent glasses were developed as a phosphor-containing medium. They are formulated to provide chemical compatibility with electroluminescent phosphors and to match thermal expansion values of glass and ceramic substrates.

The glasses are usually supplied as 400-mesh powder, but are also available in the form of a frit. The powder or frit is mixed with phosphors and applied to a substrate by silk screening, spraying or similar methods. The vehicle is then removed by heat treatment, and the electroluminescent layer sealed to the substrate by firing at 1100 to 1200 F.



***Dome window** of new glass is said to make possible the detection of relatively low temperature targets by "heat-seeking" missiles. Flat piece in background, measuring 12 in. square by ½ in. thick, is recommended for use in optical instruments.*

Code 1970 glass can be sealed to substrate materials with thermal expansion coefficients ranging between 47 and 52 $\times$ 10^{-7} per °F.

Code 1971 glass is tailored to match the thermal expansion coefficient of Fotoceram substrates and other materials with linear expansion in the range of 58 to 63 $\times$ 10^{-7} per °F. Fotoceram is a high temperature, opaque glass-ceramic that is chemically machinable. KEY NO. 614

3. Moisture-absorbing glass

The moisture-absorbing glass, supplied in the form of disks, is designed for use in semiconductor enclosures. The material is a porous 96% silica glass.

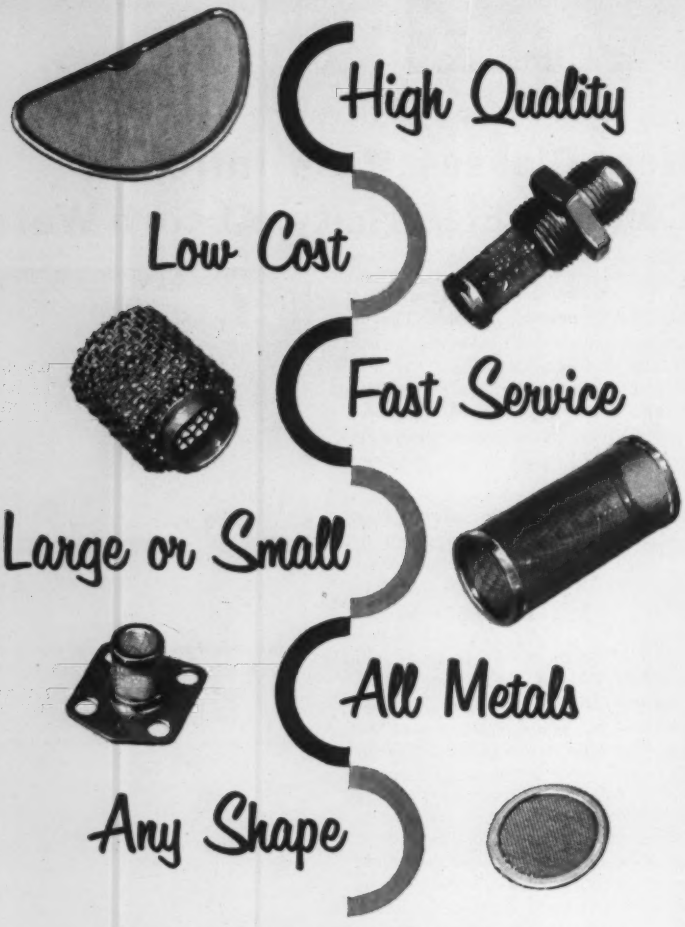
Corning says the disks, called moisture getters, are available with or without holes, in thicknesses of 0.030 in. or more.

Getters are placed in semiconductor enclosures because of the tendency of such devices to become less efficient in the presence of moisture. The porous glass used in the getter contains billions of submicroscopic holes that have an average diameter of about 40 angstrom units.

KEY NO. 635

(continued on p 210)

WIRE CLOTH PARTS



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For more information, turn to Reader Service card, circle No. 462

What's new IN MATERIALS

PROPERTIES OF CODE 9752 INFRARED TRANSMISSION GLASS

MECHANICAL PROPERTIES	
Density, lb/cu ft	0.163
Young's Modulus, 10^6 psi	8.74
Shear Modulus, 10^6 psi	3.80
Mod of Rupture (abraded), psi	5520
Poisson's Ratio	0.15
Knoop Hardness (100 gm)	530
THERMAL PROPERTIES	
Coef of Ther Exp (32-575 F), per °F	48.1×10^{-7}
Specific Heat (77-1200 F), Btu/lb/°F	0.14
Service Temp, F	
Normal	260
Extreme	1100
Strain Point, F	1170
Annealing Point, F	1225
Softening Point, F	1445
ELECTRICAL PROPERTIES	
Dielectric Constant (10^6 cps)	
77 F	12.5
1380 F	13.2
Loss Factor	
77 F	0.0015
1380 F	0.0019
Volume Resistivity, ohm-cm	
480 F	13.4
660 F	11.0

4. Clear sealing glasses

Clearform is the name of Corning's new clear sealing sintered glasses. Glass-to-metal seals made with these materials can be readily checked for quality by observing the seal through the glass.

The clear glasses are made by pressing small glass particles to shape, and then firing the piece at high temperatures. The particles are consolidated by fusion into a non-porous, vacuum-tight structure.

According to Corning, Clearform can be produced in a variety of close tolerance shapes that retain the thermal endurance, corrosion resistance and dielectric strength of the parent glass. KEY NO. 615

Parts Aluminized by Cold Spraying, Heating

Aluminized metal parts for high temperature service are being turned out by a new process in which an aluminum coating is applied cold by means of mechanical spray equipment, then "furnace-bonded" to the

ACCURATE PRENOTCHING OF ROLL FORMED SHAPES

cuts assembly costs

Our accurate method of pre-notching, forming, and cutting your metal shapes and sections to lengths will reduce your costs.

Finished sections ready for final assembly can be delivered to meet your exact schedules.

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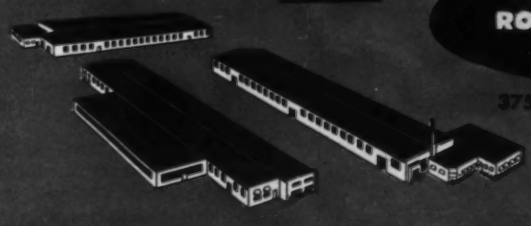
Let us show you how our continuous pre-notching and forming operations can reduce your costs for special shapes and sections.

Do you have our catalog No. 1555?

SEE OUR CATALOG IN SWEET'S



ROLL FORMED PRODUCTS COMPANY

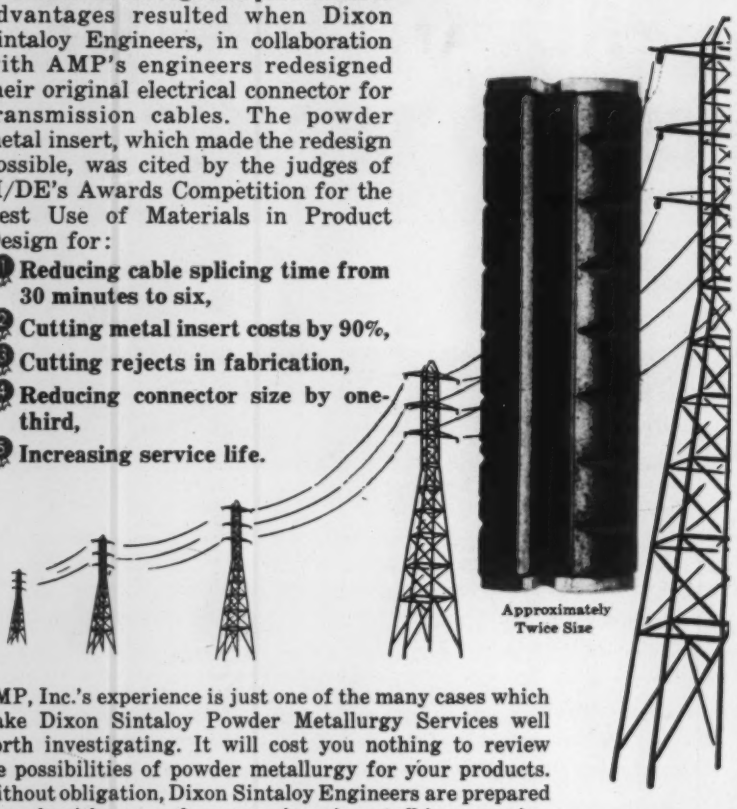
3752 Oakwood Ave., Youngstown, Ohio

For more information, turn to Reader Service card, circle No. 468

This AWARD WINNING powder metallurgy part CUT COSTS 90%*

Tremendous savings and performance advantages resulted when Dixon Sintaloy Engineers, in collaboration with AMP's engineers redesigned their original electrical connector for transmission cables. The powder metal insert, which made the redesign possible, was cited by the judges of M/DE's Awards Competition for the Best Use of Materials in Product Design for:

1. **Reducing cable splicing time from 30 minutes to six,**
2. **Cutting metal insert costs by 90%,**
3. **Cutting rejects in fabrication,**
4. **Reducing connector size by one-third,**
5. **Increasing service life.**



Approximately Twice Size

AMP, Inc.'s experience is just one of the many cases which make Dixon Sintaloy Powder Metallurgy Services well worth investigating. It will cost you nothing to review the possibilities of powder metallurgy for your products. Without obligation, Dixon Sintaloy Engineers are prepared to work with you and your engineering staff in surveying your present parts and assisting you in their evaluation for adaption to this mass production and cost reducing process. The free illustrated brochure gives you further facts and design data. Write for it today.

**See page 160 for complete details of AMP, Inc.'s prize-winning cable connector.*

Visit us at Design Engineering Show—Booth 2102

DIXON SINTALOY INC.

a subsidiary of The Joseph Dixon Crucible Company

533 Hope Street, Stamford, Connecticut

For more information, turn to Reader Service card, circle No. 530

What's new IN MATERIALS

base metal at high temperatures in a controlled atmosphere.

The method is said to produce aluminized parts with good resistance to oxidation, corrosion, abrasion and erosion.

The process is in operation at the Stainless Processing Div. of Wall Colmonoy Corp., 19345 John R. St., Detroit 3. The company says the process can be used to aluminize 400 series stainless steels, all carbon steels, austenitic stainless steels, and a variety of alloy steels.

KEY NO. 616

Large PVC Parts

Large, rigid PVC (polyvinyl chloride) plastics products are being produced by a new technique that is said to overcome one of the major problems in processing rigid PVC—namely degradation of the material. Degradation is said to cause low tensile strength and poor resistance to acids.

The process was developed by General American Transportation Corp., Plastics Div., 135 S. LaSalle St., Chicago 3. Details as to how it works have not been revealed. However, laboratory tests reportedly show that large, rigid PVC products made by the process have high tensile strength and good resistance to 93% sulfuric acid. KEY NO. 617

Steel-Bonded Carbide Can Be Machined

A new addition to a line of cemented carbides, known as Ferro-Tic and produced by powder metallurgy techniques, has been announced by Sintercast Div. of Chromalloy Corp., 132 Woodworth Ave., Yonkers 2, N. Y.

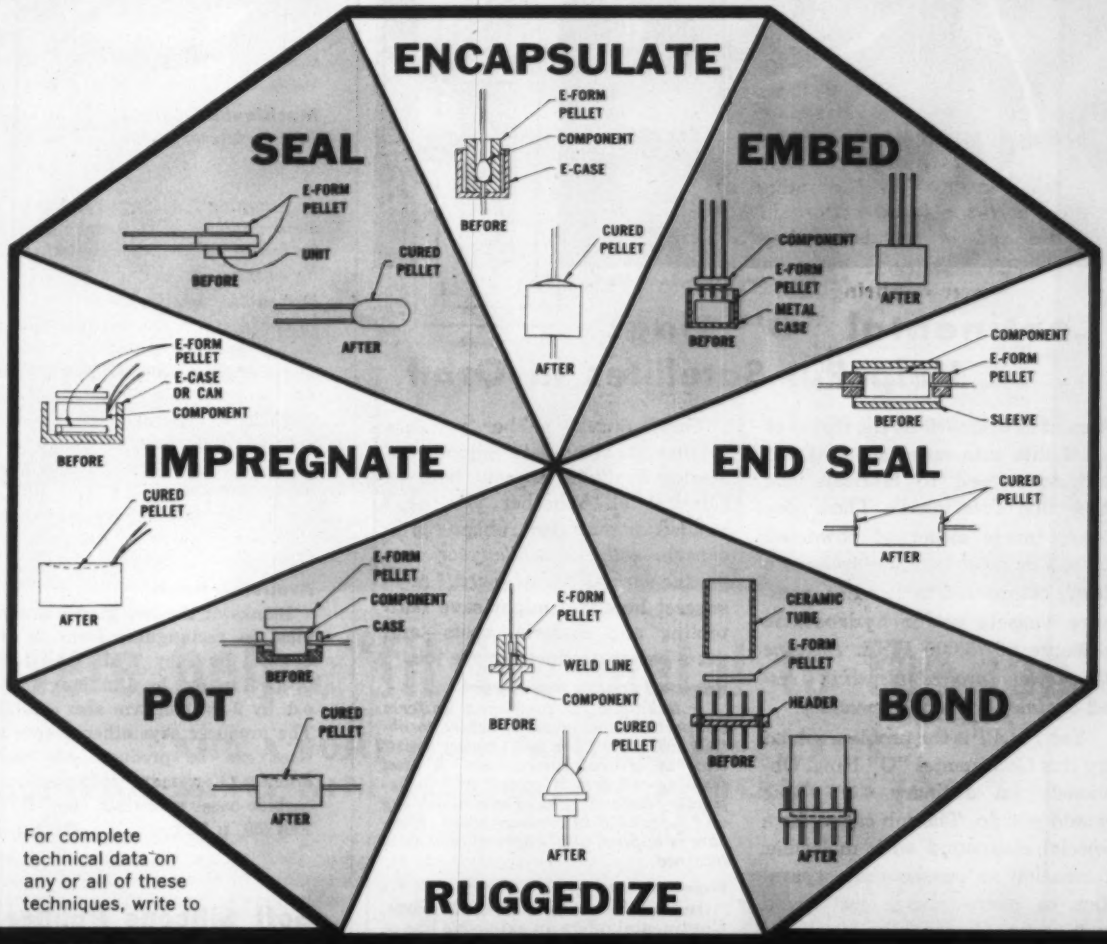
The new product, called Ferro-Tic S, is a machinable grade of stainless steel-bonded titanium carbide made by powder metallurgy techniques.

Two grades are available with Rockwell hardnesses of C45 and C55, respectively. The softer of the two, Ferro-Tic S45, can be machined with any single or multiple point cutting tool. Ferro-Tic S55 can only be sawed, turned or drilled; milling

8 ways to use versatile E-FORM EPOXY PELLETS

Developed to overcome the measuring and handling drawbacks of liquid epoxy, E-FORM EPOXY PELLETS are non-toxic, dry, easy-to-handle units that can be provided in the exact size, shape, volume and formulation required for any insulating, adhesive, chemical resistant or flame-resistant application! Variations of cure temperature, color, flow and viscosity, heat dissipation, thermal expansion, physical and adhesive strength, flexibility, etc., are available to raise production efficiency, save time, cut rejects drastically and raise the standard of component performance.

Here are 8 ways to use versatile E-FORM EPOXY PELLETS in your plant now:



For complete technical data on any or all of these techniques, write to

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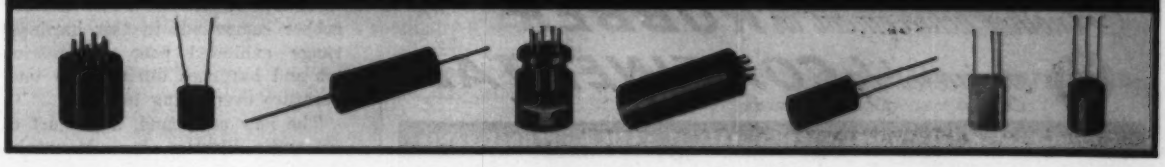
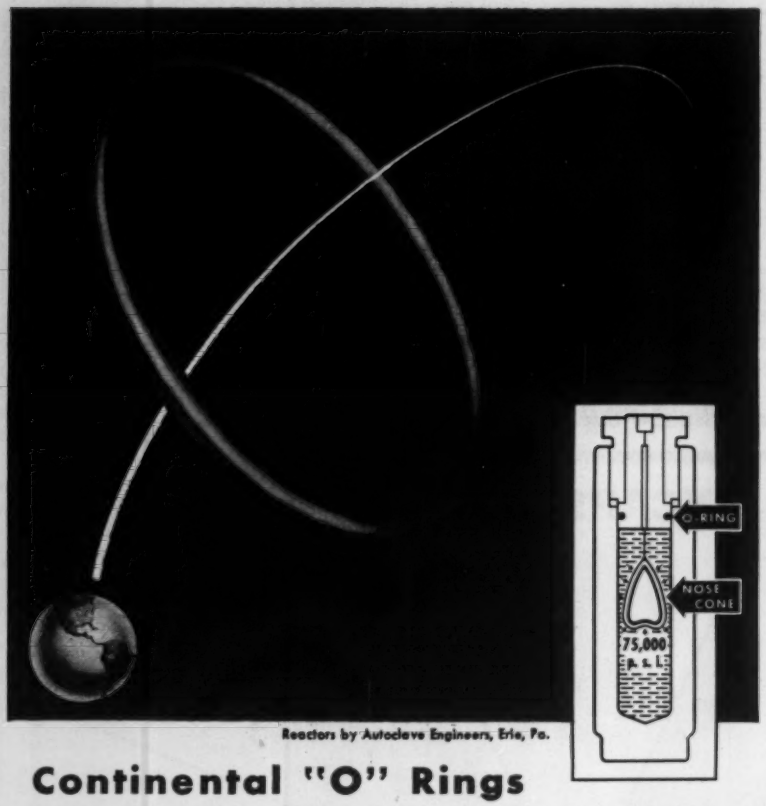


For more information, turn to Reader Service card, circle No. 481



Reactors by Autoclave Engineers, Erie, Pa.

Continental "O" Rings Help Put Satellites in Orbit

Almost as dramatic as the thrust of a satellite into outer space is the technique used to fabricate the nose cone of the missile. These nose cones, made either of powdered metals or refractory materials, are being compacted in 12" I.D. pressure vessels under hydrostatic pressure of 75,000 P.S.I. *Imagine the problem involved in sealing a vessel against such terrific pressure!*

Yet *THAT* is the problem solved by this Continental "O" Ring. Obviously an ordinary "O" Ring would not do. The job called for a special compound with molecular formation so precise that separation or micro-leakage just could not occur. Continental developed the compound that meets this rigid test. What's more, the elasticity of the rubber refuses permanent set and thus permits re-use of the ring.

This unusual rubber problem typifies the complete engineering service available to you here at Continental. Whether you need molded or extruded rubber parts, consult with us *while your new products are still on the board.* Let us suggest how you might save both tooling and material costs—and get a better product for the job.

Hydrostatic Pressing (see diagram).

A technique for producing uniform compaction and grain structure to obtain super hardness and impact resistance in critical components. A steel forming-mandrel is coated with a refractory material, placed in a rubber bag and suspended in pressure vessel. Pressure is applied until required density is attained.

Engineering catalog.

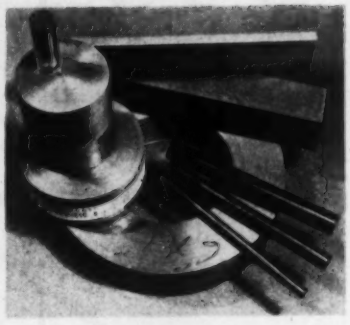
In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.

Another achievement in **RUBBER**
engineered by **CONTINENTAL**

CONTINENTAL RUBBER WORKS • 1985 LIBERTY ST • ERIE 6 • PENNSYLVANIA

For more information, turn to Reader Service card, circle No. 510

What's new IN MATERIALS



***Machinable carbide** is available in a variety of shapes and sizes.*

or tapping is not recommended. Both grades can be ground, and can be joined to other metals by welding or brazing.

Potential applications

The material is recommended for valves and valve seats in the food and chemical processing industries; for knives and choppers where cleanliness and corrosion resistance are required; and for pump seals, homogenizing valves, nozzles, gages, high temperature bearings, forming tools, and other items where cast cobalt-base alloys or tungsten carbides might normally be used.

Available forms

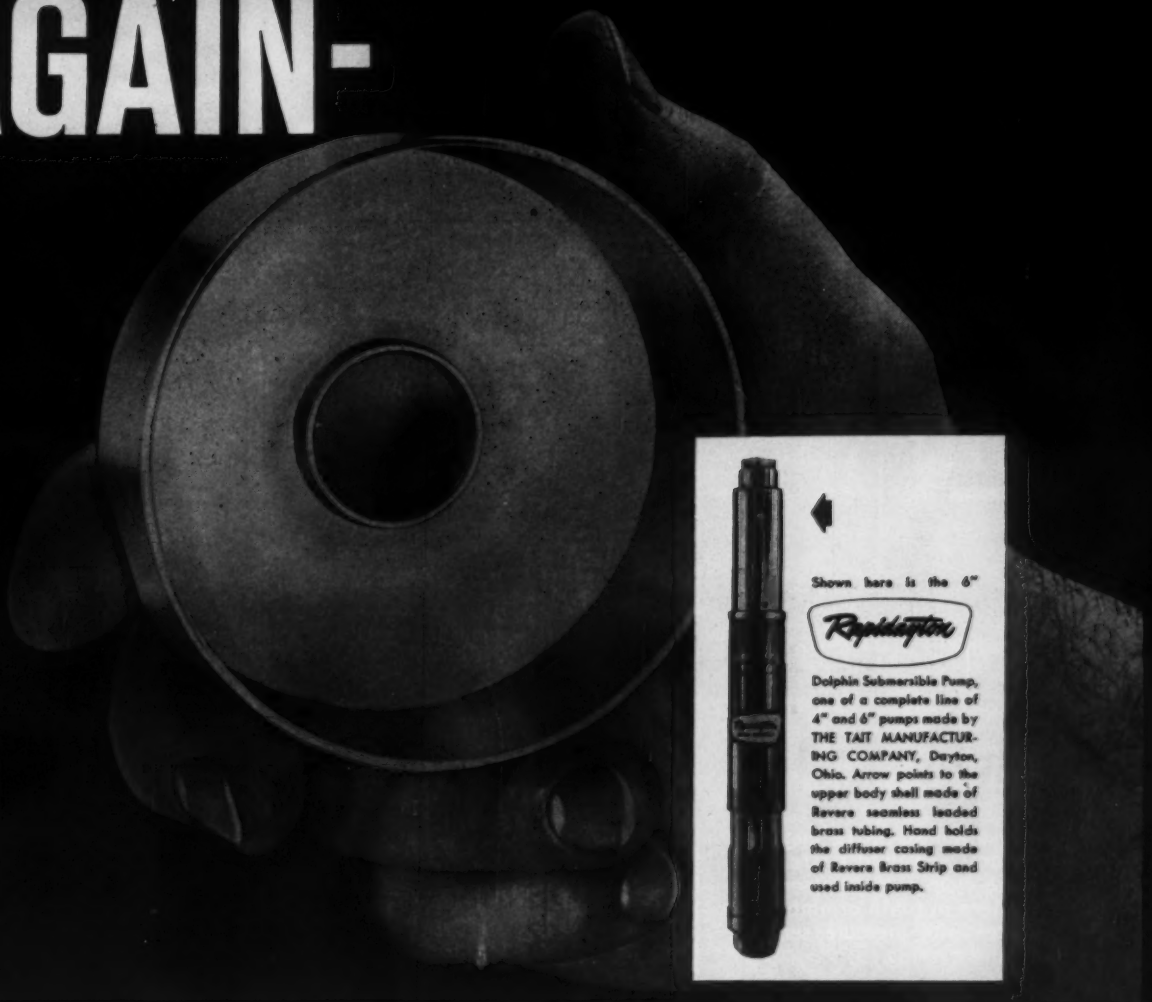
Blanks of the two grades are supplied in rectangular form in sizes up to 1 by 2 by 7 in. Round bars up to 2 in. o.d. by 6 in. long or 6 in. o.d. by 2 in. long are also available. The producer says other shapes and sizes can be produced on special order. (For more information on carbide-base materials, see M/DE, Feb '59, p 79.) KEY NO. 618

Soft Silicone Rubber Is Resilient at 450 F

A soft silicone rubber compound with a Shore A Durometer hardness of 10 does not harden or become brittle after heat aging at temperatures up to 450 F. Prior silicone rubber compounds in this hardness range exhibited poor compression set and hardened during high temperature oven aging tests.

The new compound, a product of Edenville Plastics, Inc., Mountain-

AGAIN-



Shown here is the 6" Rapidaptor Dolphin Submersible Pump, one of a complete line of 4" and 6" pumps made by THE TAIT MANUFACTURING COMPANY, Dayton, Ohio. Arrow points to the upper body shell made of Revere seamless leaded brass tubing. Hand holds the diffuser casing made of Revere Brass Strip and used inside pump.

Revere helps "fit the metal to the job"

AND A PUMP MANUFACTURER FABRICATES SUPERIOR PARTS WITH GREATER EASE . . . INCREASES TOOL LIFE

An important part of the submersible pumps made by Tait Manufacturing Company is the brass diffuser casing you see above. This part had formerly been made of ferrous metal. While satisfactory as a pump part it was difficult to work and draw . . . at the same time tool life was short.

One of Revere's Technical Advisors was asked to study the problem. Revere Cartridge Brass Strip of a certain temper was recommended, samples submitted, and, after extensive tests, was approved. The customer has found that not only does the diffuser casing, made of Revere Brass, perform well in the pump, but it also has superior drawing properties, is more easily worked, and tool life has been substantially increased.

This meticulous attention to "fitting the metal to the job" also resulted in Tait Manufacturing Company's specifying Revere seamless leaded brass tubing for the upper body shell of its submersible pumps. Here the application called for extremely close straightness and roundness control which meant special attention to detail on the part of the Revere mills.

Why not put the extensive knowledge of Revere's T.A. Service to work for you? With the wide variety of metals at your disposal, perhaps Revere can help you select the one best suited for the job, with a resultant saving of money while improving product quality.

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

Executive Offices; 230 Park Avenue, New York 17, N. Y.

Mills: Rome, N. Y.; Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles, Riverside and Santa Ana, Calif.; New Bedford, Mass.; Brooklyn, N. Y.; Newport, Ark.; Fort Calhoun, Neb.
Sales Offices in Principal Cities, Distributors Everywhere.

For more information, turn to Reader Service card, circle No. 436

Add New Sparkle to YOUR Product!

SELF-ADHERING
MIRRO-BRITE
METALIZED MYLAR*

LOOKS AND LASTS LIKE METAL!

There are countless ways that you can use MIRRO-BRITE metalized "Mylar"... and at little cost. Choose from a large assortment of colors in plain or embossed patterns with pressure sensitive adhesive backing.

MIRRO-BRITE is available in continuous rolls, cut-to-sheet sizes or die-cut to any shape you require for simple application.

Our skilled specialists will be happy to consult with you with no cost or obligation.

*Mylar Dupont Polyester Film

Write for actual samples and prices.

COATING PRODUCTS, INC.
DEPT. MDE 101 W. FOREST AVE. ENGLEWOOD, N.J.
PIONEERS in METALLIZED MATERIALS!
Manufacturers of Mirro-Brite "Mylar," Acetate, Polystyrene and Butyrate.

See us at booth #2013 Design Engineering Show
For more information, circle No. 350

What's new IN MATERIALS

PROPERTIES OF SOFT SILICONE RUBBER

ORIGINAL PROPERTIES	
Tensile Strength, psi	525
Elongation, %	625
Hardness (Shore A)	10
Compression Set (70 hr at 300 F), %	29
AFTER HEAT AGING	
Hardness Change (Shore A), %	
70 Hr at 350 F	0
24 Hr at 450 F	0

side Rd., Warwick 2, N. Y., is recommended for use as gaskets in aircraft parts. The material is supplied in sheets 14 by 21 in., in thicknesses from 1/32 to ¼ in. The compound can also be supplied in molded or die-cut shapes. KEY NO. 619

Solder-Clad Metal Makes Brazing Easier

Metal strips clad with hard solders for use in brazing operations are available from Metals & Controls Div., General Plate Products Group, Texas Instruments Inc., 34 Forest St., Attleboro, Mass.

A big advantage of the clad strip is that it eliminates the need for the separate fabrication of small pieces of solder which are usually used in conventional brazing operations. Other advantages: the clad strip decreases the number of surfaces to be cleaned and fluxed, and it insures uniform wetting of surfaces to be joined.

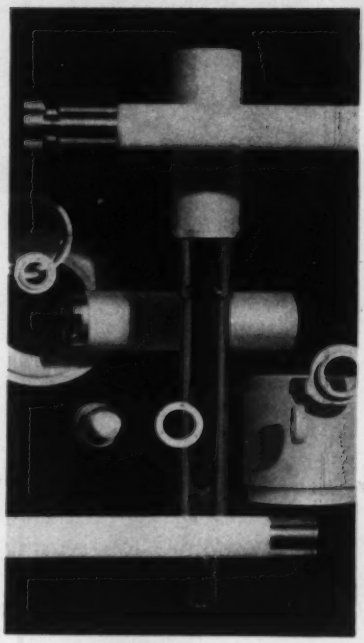
Wide choice of materials

Silver solders available in clad form include all the usual alloys with copper, zinc, tin, cadmium, nickel, manganese, phosphorus and lead. Noble metal solder alloys for all types of gold, platinum or palladium brazing are also available. Special solder alloys can be produced for specific new applications, according to the producer.

The solders can be clad on one or both sides of any base or precious metal strip. Base metals frequently used are copper and copper alloys, nickel and nickel alloys, carbon steels, and stainless steels.

Many sizes, ratios available

Composites other than stainless steels can be supplied up to 0.50 in.



Coors

Alumina Ceramics Replace Expensive Metals for Vital Pump Parts

The destructive twins—corrosion and abrasion—have led pump designers to use Coors High Strength Alumina Ceramics for the vital parts of pumps, such as plungers, cylinder liners, seal faces in mechanical shaft seals, shaft protection sleeves, and ball check valves.

Perhaps your abrasive and corrosive problems can be solved economically with Coors Ceramics. We shall be glad to help you—just write us at Golden or contact one of our regional sales managers.

REGIONAL SALES MANAGERS

West Coast—William S. Smith, Jr. EM 6-8129—Redwood City, Calif.
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East Coast—John J. McManus MA 7-3996—Manhasset, N.Y.
New England—Warren G. McDonald FR 4-0663—Schenectady, N. Y.
Southwest—Kenneth R. Lundy DA 7-5716—Dallas, Texas
Oil Field Industry—William H. Ramsey UN 4-6369—Houston, Texas

Coors
COORS PORCELAIN COMPANY
600 Ninth St., Golden, Colorado

Design Show Booth 1108
For more information, circle No. 389

VISIT US AT THE
DESIGN SHOW
BOOTH NUMBER 834

created alloys for critical casting requirements . . .

In less than a decade, Waukesha Foundry Company has created 5 corrosion-resistant, non-galling alloys.

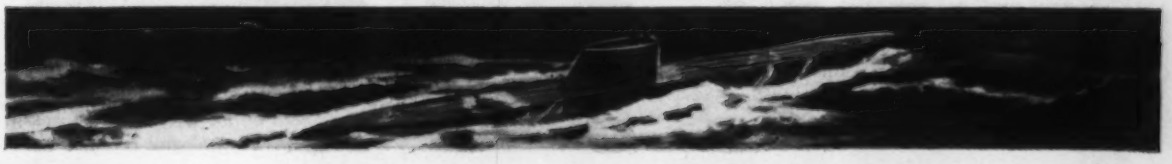
Space vehicles, ships on and beneath the sea, nuclear reactors . . . Waukesha is presently serving these areas where precision engineered castings are an absolute requirement.

Waukesha provides quality "Spectrometer" control with each heat, pilot plant facilities, sand, shell, ceramic-type moldings, and a metallurgical staff with an impressive history in "created metals".

From the blueprint to the finished casting, cousult Waukesha.

Waukesha Foundry Company

Dept. F-7 Waukesha, Wisconsin



For more information, turn to Reader Service card, circle No. 507

FELT
BY FELTERS

PROVIDES DEPENDABLE,
LOW-COST PARTS FOR

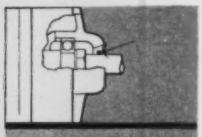
ELECTRIC MOTORS

Seals . . . wicks . . . lubricators . . . washers . . . gaskets — are all vital electric motor parts that benefit from Felt by Felters.

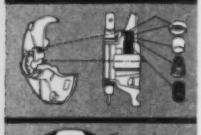
A special Felters' "Engineered Fabrication" processes felt to specific thickness, density, hardness, and resiliency; and provides special characteristics such as absorption, stiffness, water repellency and flameproofing.

And, new felt and plastic laminates, called PlastiFelts, use synthetics such as Nylon, Teflon, Hycar and rubber to provide an even wider range of application, plus greatly improved performance.

These are some of the many electric motor applications where Felt by Felters offers both a low-cost and high performance material for non-metallic parts.

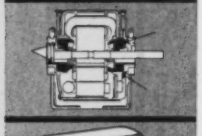


Felt seal inserted around shaft opening retains grease and keeps out foreign matter.

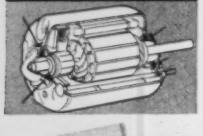


This self-oiler uses a felt wick, bearing against the shaft under spring pressure, for constant lubrication.

This is a thrust washer designed for double duty as a lubricator by the use of a felt ring and lubricating notches.



Lifetime bearing lubrication is possible by selection of correct SAE grade, and designing into sealed bearing.



Felters' "Engineered Fabrication" makes it possible to specify felt shapes for a complete motor and shaft lubricating system, combining reservoirs, and wicking, and directing oil flow to all required areas.

To get the most out of Felt, send for the Felters Design Book — a complete digest on properties and applications. Write, today.

Ask for **FELT** *from . . .*

The **FELTERS** Co.

220 SOUTH STREET
BOSTON 11, MASSACHUSETTS

Pioneer Producers of Felt and Synthetic Non-Woven Fabrics MD-6

For more information, turn to Reader Service card, circle No. 400

thick by 20 in. wide. Solder-clad stainless steel is available up to 0.062 in. thick by 10-12 in. wide. Cladding ratios range from 5:95 to 70:30 for single-clad material and from 5:90:5 to 35:30:35 for double-clad material.

Solder-clad tubing, and solder-clad and solder-cored wire, are also available. **KEY NO. 620**

Irradiated Polyethylene for Shrink Packaging

Irradiation is being used by the Cryovac Div. of W. R. Grace & Co. to produce a low cost polyethylene packaging film with high shrink energy. The new film is called Cryovac Type L.

Uses related to price

The company, located at 3 Hanover Square, New York 4, says the irradiated film is especially suited for packaging fruits and vegetables, meat and poultry, and bakery and confectionary products. It is also expected to be used for standard overwrap packaging of many other consumer products in clear, skin-tight packages.

In the course of test marketing, more than a million pounds have been sold for packaging meat and poultry products at a price of 3¢ per 1000 sq in. of 1-mil film. This price is comparable to those of other pack-

***Polyethylene film** that has been irradiated by an electron beam generator has high shrink energy.*

Flat bed body which generally transports solid cargo is quickly converted to a liquid carrier . . . with a SEALDTANK*

ENJAY BUTYL

Converts trucks to liquid carriers in minutes!

Enjay Butyl is used by the United States Rubber Company for "Sealdtanks" carrying up to 4,200 gallons. Sealdtanks are tube-like containers that can be rolled into compact units and stored on the truck when it returns with dry cargo. Note rolled Sealdtank at rear. Why was Enjay Butyl chosen for Sealdtanks? Because its excellent resistance to many chemicals, its remarkable toughness as well as all-weather resistance make it a most practical container for transporting various liquids.

*Trademark, U.S. Rubber Co.

Versatile Butyl may well help improve the performance of your own products. Complete information and expert technical advice is available to you from Enjay.

ENJAY BUTYL

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

ENJAY COMPANY, INC.

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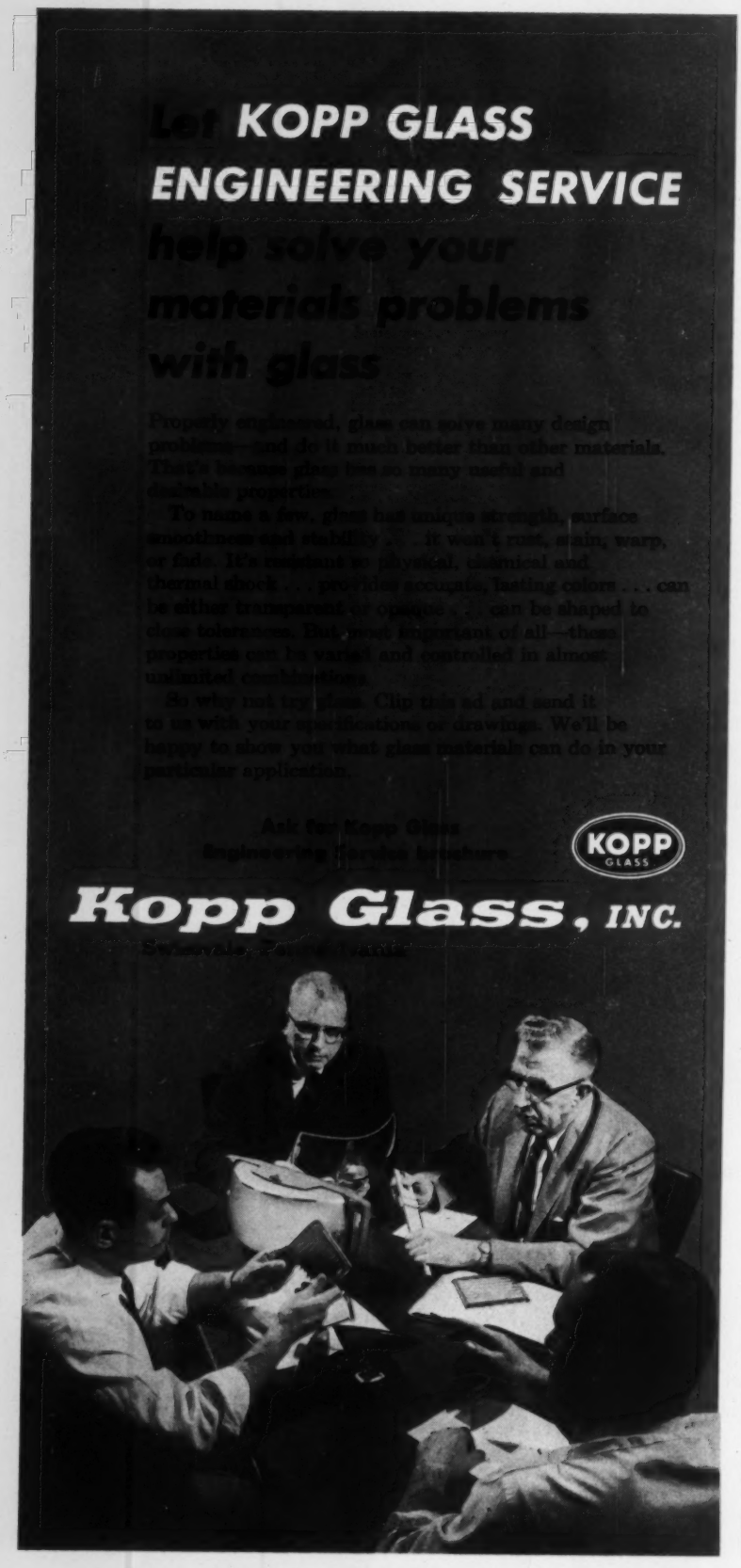


What's new IN MATERIALS

PROPERTIES OF CRYOVAC TYPE L FILM

PHYSICAL PROPERTIES	
Specific Gravity	0.92
Water Absorption (24 hr), %	Nil
Water Vapor Permeability (100 F, 90% RH), gm/24 hr/100 sq in.	0.6-0.7
Haze, %	0.8-1.2
Gloss (Photovolt) at 70-Deg Angle, %	103
Flammability	Slow burning
MECHANICAL PROPERTIES	
Tensile Strength, psi	8000-16,000
Elongation, %	60-90
Bursting Strength (Mullen), psi	35-45
ELECTRICAL PROPERTIES	
Dielectric Constant	2.3-2.4
Volume Resistivity, ohm-cm	10^{18}
Loss Factor	0.00015-0.0005

aging films for similar applications: 2.7 to 3.3¢ for cellophane, 4¢ for saran, and 4.36¢ for Videne polyester. On the same basis, regular polyethylene film sells for 2.7 to 3.3¢.

How film is made

From a purely chemical standpoint, the film is said to be identical with conventional polyethylene being used on all types of food products. According to the producer, electron bombardment does not make the film radioactive.

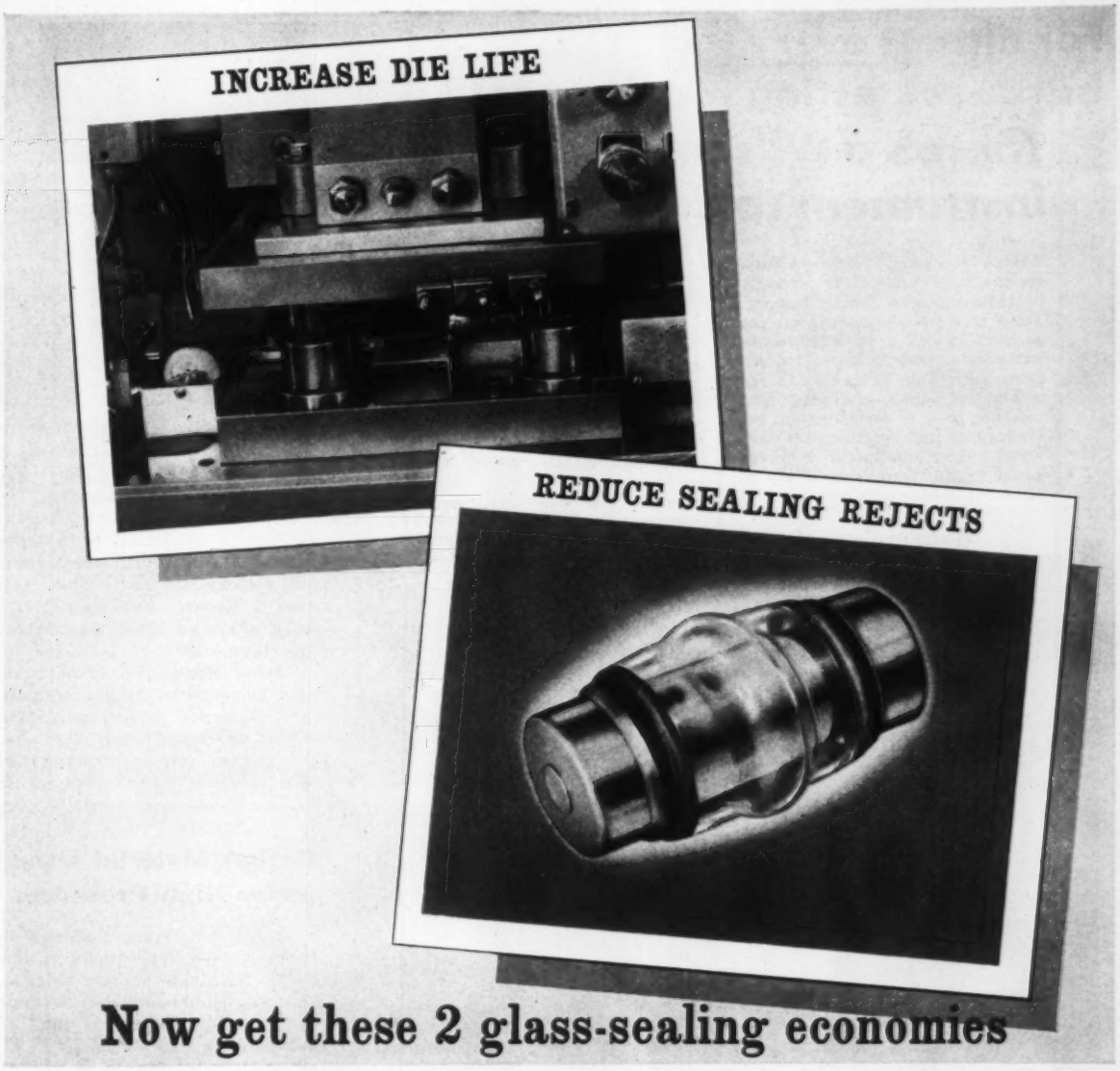
To produce the new packaging material, polyethylene film is extruded into tape and passed under an electron beam generator. The high energy source causes the material to become crosslinked. In crosslinking polyethylene, hydrogen atoms are knocked off the polymer chains leaving active free radicals which join to form a three-dimensional network of carbon-to-carbon bonds. The displaced atoms are removed in the form of a gas. (For more information on the electron bombardment of polyethylene, see *Materials & Methods*, Sept '54, p 91.)

Irradiation increases strength more than 500% and makes it possible to stretch the material in both directions more than 200%. After stretching, the film can be slit to size for any packaging application.

Irradiated film has high shrink energy

The stretching process, known as biaxial orientation, imparts to the film one of its most dramatic char-

For more information, turn to Reader Service card, circle No. 513



Now get these 2 glass-sealing economies

with THERLO* The only commercial vacuum melted glass sealing alloy available...No price increase.

Therlo—now a commercially vacuum melted alloy made *only* by Driver-Harris—is such a metallurgically cleaner metal that it has *greater ductility* and a *better surface* than any other alloy used for the same glass-to-metal sealing applications.

For this reason it is more easily formed into desired shapes and increases die life 25-50% between sharpenings. And Therlo produces a permanent vacuum tight seal with negligible leakers on the production line.

Therlo matches such commercially hard glasses as Corning #7052 and #7040 in expansivity from 80° C to the annealing point. In every case where Therlo has been specified the resulting reduction in rejects both in fabrication and glass-sealing production have cut production costs impressively.

Therlo is one of four D-H alloys developed for glass-to-metal sealing of both hard and soft glass in most every sealing operation. For more information write to .....

*T.M. Reg. U.S. Pat. Off.

DRIVER-HARRIS* COMPANY

HARRISON 30, NEW JERSEY •

Distributors: ANGUS-CAMPBELL, INC., Los Angeles, San Francisco
J. M. TULL METAL & SUPPLY CO., INC., Atlanta

BRANCHES: Chicago, Detroit, Cleveland, Louisville •

In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario

MAKERS OF THE MOST COMPLETE LINE OF ALLOYS FOR THE ELECTRICAL, ELECTRONIC, AND HEAT-TREATING INDUSTRIES

SPECIAL PURPOSE ALLOYS SINCE 1888 D/H TRADE MARK REG. U.S. PAT. OFF.

For more information, turn to Reader Service card, circle No. 478

For almost every hardness testing requirement

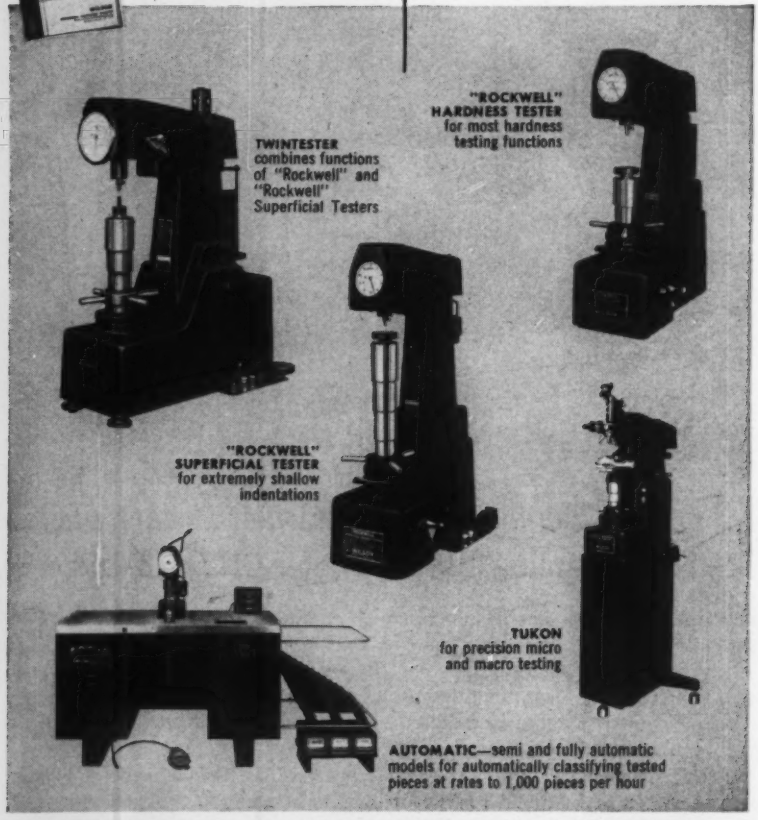
There's a Wilson "Rockwell" instrument to do the job

Wilson "Rockwell" Hardness Testers can help make your products better, stronger, longer lasting. They give reliable results on the production line, in laboratories, in tool rooms, and in inspection departments. They're as easy to use as a center punch, as durable as a machine tool, as sensitive and accurate as a precision balance. That's why Wilson "Rockwell" is recognized as the world's standard of hardness testing accuracy.

Write for Catalog RT-58. It gives complete details on the full line of Wilson hardness testing equipment.

Wilson "Brale" Diamond Penetrators give Perfect Readings

A perfect diamond penetrator is essential to accurate testing. Only flawless diamonds are used with Wilson "Brale" penetrators. Each diamond is cut to an exact shape. Microscopic inspection and a comparator check of each diamond—one by one—assure you of accurate hardness testing every time.


TWINTESTER
combines functions of "Rockwell" and "Rockwell" Superficial Testers
"ROCKWELL" HARDNESS TESTER
for most hardness testing functions
"ROCKWELL" SUPERFICIAL TESTER
for extremely shallow indentations
TUKON
for precision micro and macro testing
AUTOMATIC—semi and fully automatic models for automatically classifying tested pieces at rates to 1,000 pieces per hour

WILSON "ROCKWELL" HARDNESS TESTERS

Wilson Mechanical Instrument Division
American Chain & Cable Company, Inc.
230-E Park Avenue, New York 17, New York

For more information, turn to Reader Service card, circle No. 414

acteristics—high shrink energy. When exposed to hot air or hot water at 180 F, the film immediately shrinks (by 20%) and will continue to shrink equally in all directions as the temperature is increased until it returns to its original size.

According to Grace, "No other film has ever been manufactured that shrinks to such an extent or with such energy."

Other irradiated products

Irradiation is also being used by General Electric Co. and Anchor Plastics Co. to produce heat resistant polyethylene parts (see *Materials & Methods*, Feb '55, p 104).

GE offers an irradiated polyethylene tape known as Irrathene 101.

Anchor Plastics Co. offers irradiated polyethylene tubing, rods and other extruded shapes, as well as custom fabricated items made from polyethylene extrusions that have been irradiated. KEY NO. 621

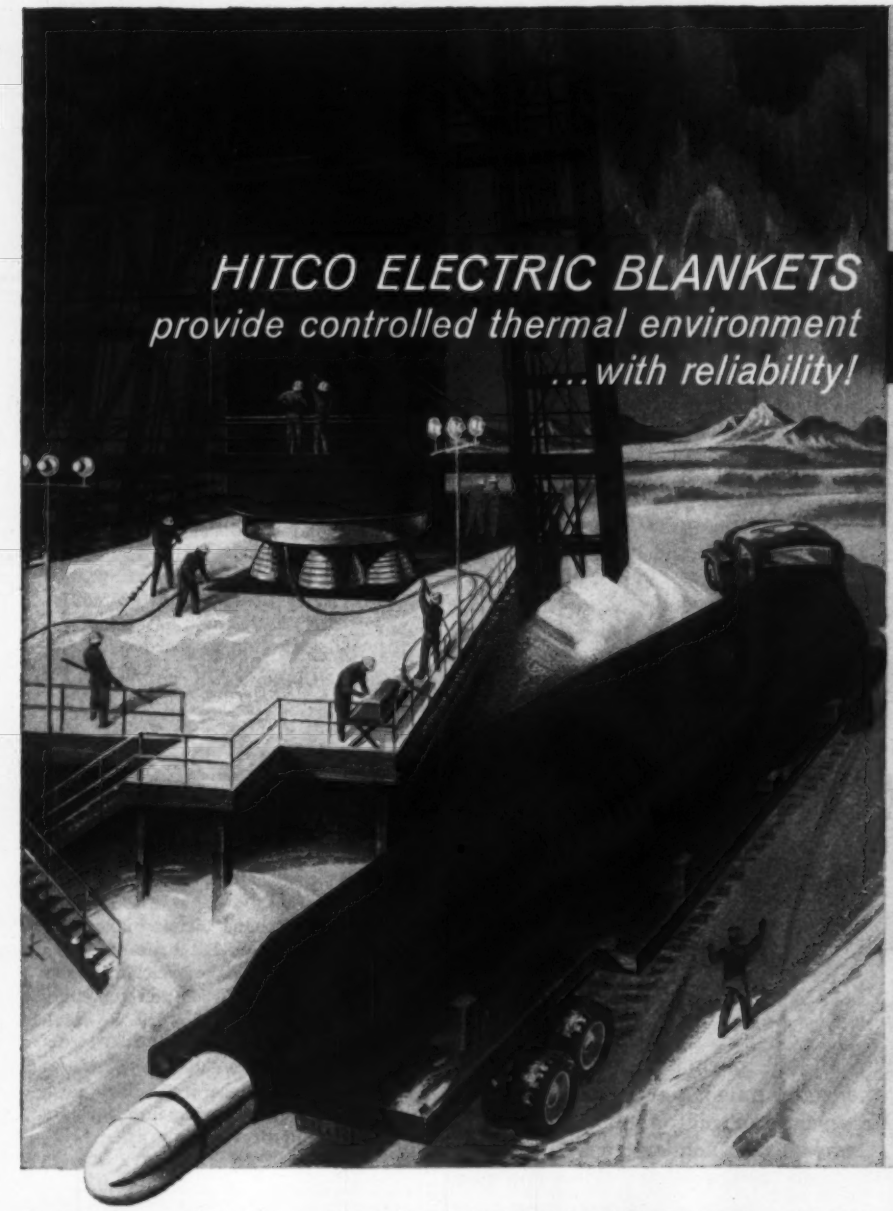
Gasket Material Used under High Pressures

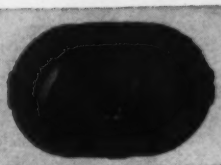
A new gasketing material for high pressure applications in automobile transmissions, rear axles and gasoline engines has been developed by Spaulding Fibre Co., Inc., 310 Wheeler St., Tonawanda, N. Y. The material, called No. 88, is resistant

Easy-to-remove gasket *results from the homogeneous dispersion of a synthetic rubber latex in the base material.*

HITCO ELECTRIC BLANKETS

provide controlled thermal environment ...with reliability!



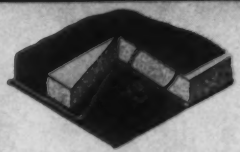


TYPICAL ELECTRIC BLANKET. This is a HITCO "form-fitting" Blanket used to control temperature of hydrogen peroxide tank.

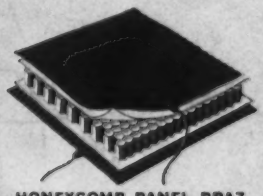
...FOR TEMPERATURE EXTREMES

−65° to

+2200°F



CUTAWAY VIEW. Shows Heating Element of HITCO Electric Blanket—sealed between cover and inner cover.



HONEYCOMB PANEL BRAZING. New HITCO Electric Blanket brazing technique provides faster, more reliable means of fabricating honeycomb structures.

INDUSTRIAL ELECTRIC HEATING ELEMENTS. HITCO Electric Heating Elements can be provided for a variety of industrial uses where a controlled thermal environment is required.

Controlled Thermal Environment prior to launch is vital to the flight success of a multi-million dollar missile. In many other industries, controlled heat is just as important.

Hitco Electric Blankets are designed to provide safe, reliable control of temperatures in a wide range from −65° to +2200°F. Hitco R&D is now developing electric blankets which will be capable of controlling ultra-high temperatures beyond the 2200°F range.

Hitco Engineers are capable of designing and manufacturing a complete Electrical Blanket System to meet your required environment. Such a system would include custom-designed blanket, connectors, thermostats and complete electrical controls. *Call or write us today!*

• *Write for Products Bulletin No. PB 7-4. Our Engineers will be glad to consult with you, without obligation, regarding your Electric Blanket and Electric Element needs.*

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to aromatic fuels and hot oils. It has high tensile strength in both machine and cross-machine directions.

The gasketing material is a rag paper stock impregnated with an SBR synthetic rubber latex. The latex, which is added to the rag paper stock by a beater addition technique, is said to give the material uniform compressibility. The latex is also said to permit easy release of gaskets without damage after long confinement under high pressures.

Graphite coatings normally used with conventional gaskets are not required with the new gasketing material, according to the developer.

KEY NO. 622

Cold Work Die Steel Is Abrasion Resistant

Latrobe Steel Co., Latrobe, Pa. has developed a new cold work die steel for use in brick mold, shot blast and ceramic tile liners, and for long run blanking and forming dies.

Designated as BR-3 die steel, the material is said to contain higher percentages of carbon and vanadium than any other cold work die steel. A typical analysis shows 2.80% carbon, 5.25% chromium, 4.50% vanadium and balance iron. The hard, abrasion resistant vanadium carbides that result provide long life.

KEY NO. 623

Compounds Added to RTV Silicone List

New compounds added to the growing list of RTV silicone rubbers include a one-component liquid compound, a low viscosity compound, and three paste-type curing agents.

1. One-component compound

The one-component liquid silicone rubber requires no premixing, and cures at room temperature by exposure to humidity in the air. A minimum of 20% RH is required to effect solidification in 24 hr.

The product, called Silastic RTV 731, is available from Dow Corning Corp., Midland, Mich. The developer says fully cured Silastic RTV 731

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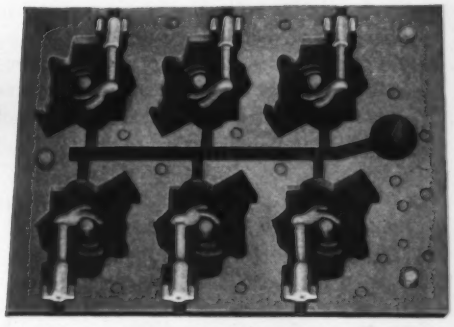
Because of the denser, non-porous, homogeneous structure, Eaton Permanent Mold Castings meet critical quality requirements. The finer dispersion of graphite provides a better material where free machinability and accuracy are essential in critical machining operations. Eaton annealed gray iron castings are available in sizes from one tenth of a pound to fifty pounds.

EATON SHELL CORING

The Eaton process of Shell Coring in permanent mold and shell molded castings provides better internal surface finish and higher dimensional accuracy. Where more than ordinary quality and control of contour are required, the Eaton process offers distinct design advantages and greater uniformity in intricately cored sections.

EATON SHELL MOLDING



Eaton Shell Molding provides more closely controlled metallurgy and hardness for applications requiring pearlitic structures, close dimensional control, and complex designs and contours. Eaton Shell Mold Castings require less machining and finishing, with resulting savings in material, tooling, and shipping.

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UNITCASTINGS provide answer for difficult parts problem!

Again, Unitcast Foundry Engineering proved invaluable in producing this hydraulic valve body casting.

Faced with the necessity of a durable, more compact unit, the customer investigated the advantages of *cast steel*. Firm specifications included small and irregular internal passages that were impossible to machine blind. Tolerances were close and exceptionally clean internal surfaces were a necessity. Shell cores, as illustrated, were used in a green sand mold. The system was streamlined and the more compact unit did not hamper the mechanism. Costs were reduced to a fraction of the alternate composite machined assembly.

Unitcastings can possibly meet your unusual problems, too. Why not investigate today . . . call for a Unitcast Sales Engineer.

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SPECIFICATION STEEL CASTINGS

For more information, turn to Reader Service card, circle No. 461

What's new IN MATERIALS

can be used for extended times up to 300 F, and for shorter periods as high as 500 F.

Tests show the material is still rubbery after exposure to 300 F for two months, and 500 F for one week. KEY NO. 624

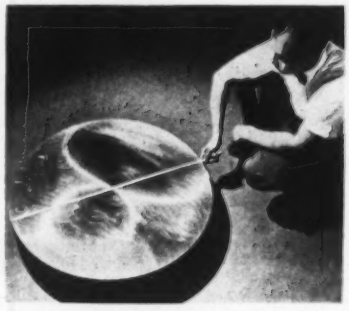
2. Low viscosity compound

The low viscosity compound, designated RTV-11 and developed by the Silicone Products Dept. of General Electric Co., Waterford, N. Y., is said to have the lowest viscosity (120 poises) of the silicone rubber compounds developed to date.

The material can be easily poured in and around irregularly shaped configurations, and is especially suited for potting, encapsulating and impregnating electrical and electronic components. One suggested application for RTV-11 is as a protective coating over printed circuit boards. KEY NO. 625

3. Three curing agents

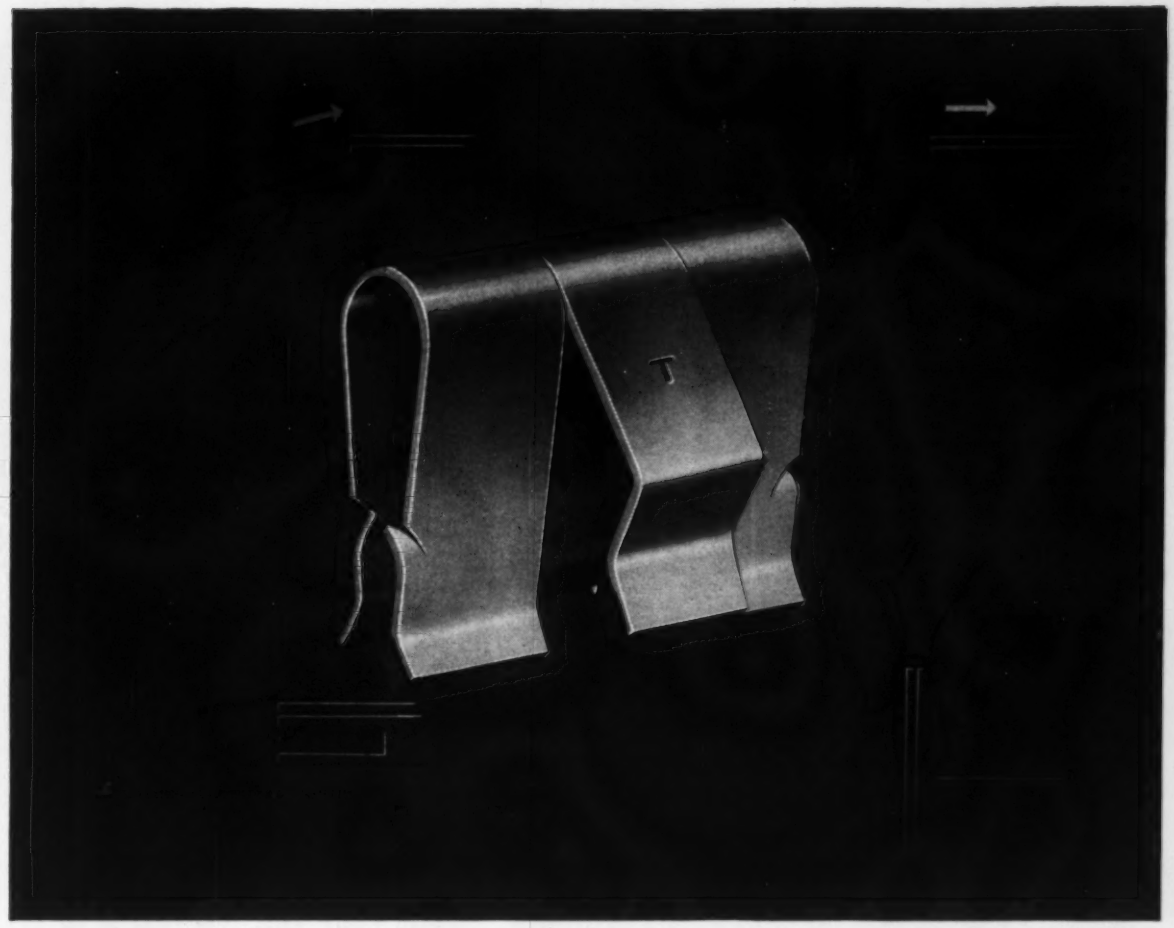
GE's Silicone Products Dept. says the three paste-type curing agents



Larger clad tube sheets—Bridgeport Brass Co., Bridgeport, Conn., recently announced that it could produce clad tube sheets 42 in. in dia. Previous limit was 26 in.

Using a patented process Bridgeport metallurgically bonds corrosion resistant materials (copper-base alloys, stainless steels, etc.) to a less expensive, less corrosion resistant base. Maximum thickness of the tube sheet is 4 in.; cladding can vary from 1/64 to ½ in.

Savings with clad tube sheets, as opposed to ones made entirely from corrosion resistant materials, range from 15 to 45%. KEY NO. 626



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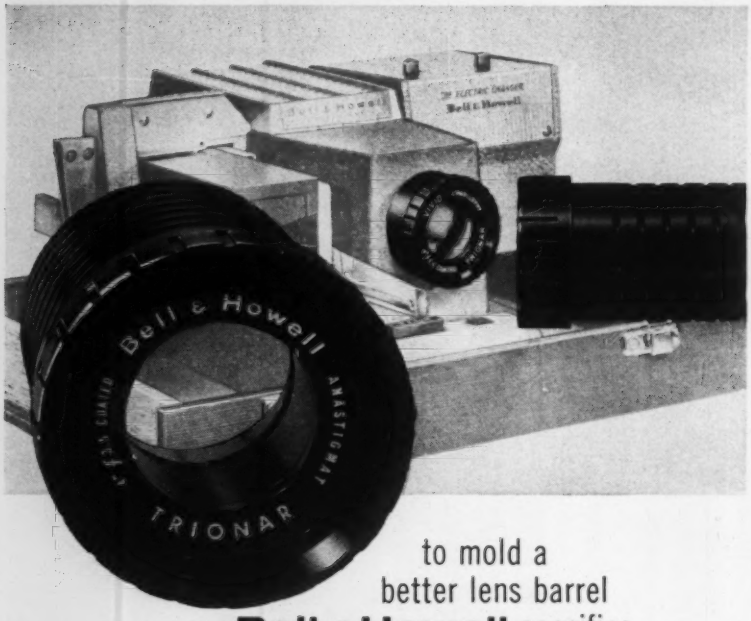
AND DOES—FOR **BELL & HOWELL**



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better lens barrel
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ROLL OUT the barrel. Or roll it in, by rotating in reverse direction. The fine lens, and its threaded barrel molded of phenolics, combine to give you excellent helical focusing of slide-showings with this projector.

It's the Headliner/706 low-silhouette slide projector, a member in good standing of the famous Bell & Howell family of quality photographic equipment. Through use of a 300-watt "short" lamp, occupying far less vertical space than conventional projector lamps, the Headliner is of extremely compact design —only 7 inches high.

Among Plenco's contributions to the production of this dependable performer is the special-purpose phenolic compound specified by Bell & Howell in the molding of the projector's accurate, smooth-turning *lens barrel*. Requirements called for a material that would assure resistance to heat, dimensional stability, and surface hardness and rigidity . . . together with a lasting, eye-appealing lustre. Plenco provided the answer. Like Bell & Howell, many other manufacturers and molders find the answer to their product or production problem in the wide variety of controlled-quality Plenco phenolic compounds. And they find consultation with Plenco technicians a worthwhile preliminary. We invite *you* to take the opportunity to talk with us, soon.

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Serving the plastics industry in the manufacture of
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For more information, turn to Reader Service card, circle No. 512

What's new IN MATERIALS

will improve and simplify the preparation of RTV silicone rubber in the following ways:

- By diluting the liquid curing agent into a paste, a greater quantity is required to effect a cure; as a result, it is much easier to accurately weigh and measure the catalyst.
- Addition of color to the paste curing agents helps assure thorough mixing and complete dispersion.

RTV-992 is orange-tan and has a specific gravity of 1.84.

RTV-993 is black with a specific gravity of 1.55.

RTV-994 is off white with a specific gravity of 1.94.

(For more detailed information on RTV silicone rubbers, see M/DE, Jan '60, p 128.) **KEY NO. 627**

Solution Removes Oxide from Aluminum

Chemclean Products Corp., 15-08 121st St., College Point 56, N. Y., says it has developed a solution that removes oxide and scale from aluminum in one operation at room temperature. The solution, called OX-Off No. 536, can also be used to clean aluminum before welding, and to remove discoloration after welding, soldering or heat treating.

Parts to be cleaned are wiped with a rag saturated in the solution, or dipped in a tank, then rinsed in water. **KEY NO. 628**

Epoxies for Tooling, Repairing, Molding

New epoxy compounds on the market include a series of one-component molding compounds, and a tooling and repair compound.

1. One-component compounds

The one-component epoxy molding compounds have been introduced by American-Marietta Co., Adhesive, Resin and Chemical Div., 3400 13th St. SW, Seattle 4, Wash.

Known as EMC, the compounds are said to have a good balance of physical, electrical and chemical properties, combined with self-releas-

ECONOMY, DURABILITY AND DEPENDABILITY are outstanding characteristics of these sintered metal gears. Parts like these are the result of close cooperation between Delco Moraine and its customers from idea through design and development to production.

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ing and self-extinguishing characteristics.

The compounds, which are supplied in a range of colors, fillers and reinforcements, are expected to be used in large-scale production of missile and electronic parts.

Parts can be made by low pressure transfer and compression molding. The compounds do not outgas during molding. KEY NO. 629

2. Tooling, repair compound

The epoxy tooling and repair compound is the newest addition to an established line of plastics tooling and repair compounds. Two types are available, No. 100, a putty-like grade, and No. 101, a liquid.

The producer, Devcon Corp., Danvers, Mass., says the compound has good tensile and compressive strength, and good resistance to most chemicals and oils. It bonds to all types of metals, wood, ceramics and other materials.

It can be used for repairing damaged machinery, foundry patterns and core boxes. It can also be used for making patterns, dies, core boxes, holding fixtures and other tools.

KEY NO. 630

Low Cost Parchment for Transformer Coils

A new type of insulating material made of vegetable parchment paper has been introduced by Paterson Parchment Paper Co., Bristol, Pa. It is designed for use in dry-type transformer coils.

Uniform dielectric strength

The dielectric material, called Patapar, is said to provide exceptionally uniform dielectric strength at less cost than other paper materials used in this application. The minimum dielectric strength of a 2-mil thick sheet of insulating parchment is 321 v per mil, compared to 336 for kraft paper and 308 for glassine paper.

Other properties

The material also offers:

1. Good machinability on automatic and semi-automatic coil winding equipment.

2. An etched surface that firmly anchors coil wires to the paper and

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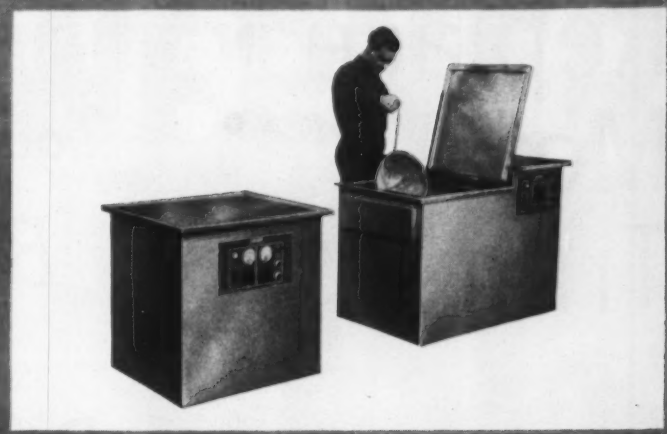

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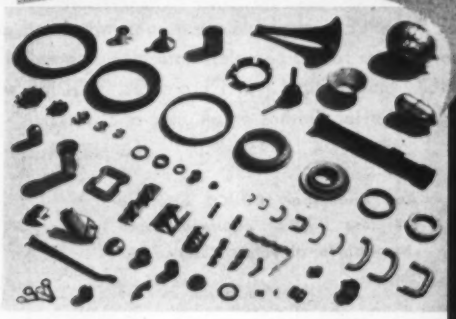

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And because Fasson Mylar Vinyl Laminates are self-adhesive, you save on the assembly line. They are applied merely by peeling off the backing paper and pressing into place. No skills or special tools are needed. No tapping, riveting or fasteners of any kind. Fasson's adhesive sticks tighter with time.

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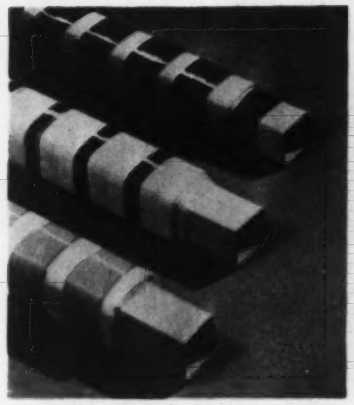


***Parchment insulation** (foreground) is said to fit tight compared to kraft (center) and glassine insulations which may telescope out of shape.*

prevents the completed coil stock from telescoping.

3. Good abrasion resistance which prevents coil wires from wearing through the paper.

4. Good resistance to temperatures up to 250 F.

5. Uniform tensile strength in both machine and cross directions.

6. Permanent wet strength so that the paper accepts encapsulating resins without losing insulating properties.

Sizes available

The parchment paper is furnished in rolls 22 in. in dia by 18 in. wide, and in sheets 24 by 36 in. Thicknesses range from 1.25 to 5 mils.

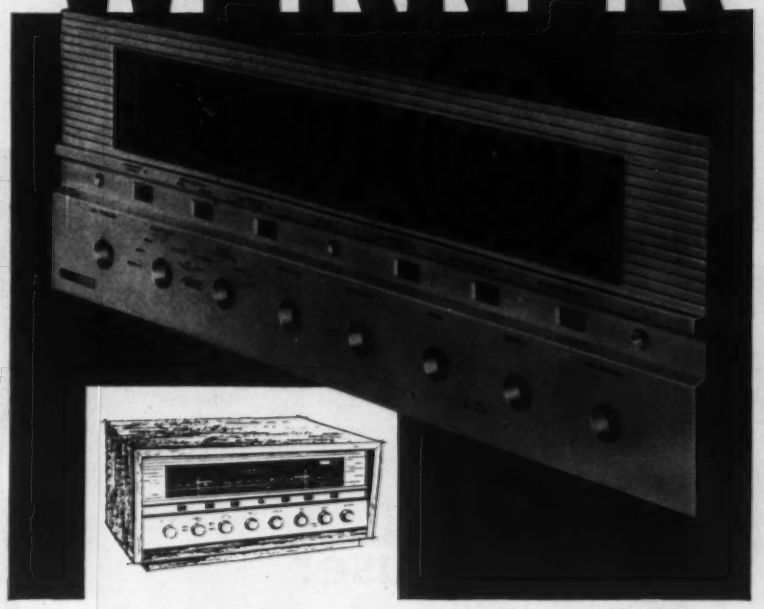
KEY NO. 631

Soldering Process Stops Metal Spatter

Experiments at the Tin Research Inst., Columbus, Ohio have resulted in a new soldering flux which spreads more smoothly over a wider area with scarcely any spattering of metal. The flux is said to cover an area of plain steel nearly twice as large as that covered by a corresponding water flux.

Polyethylene glycol, which is commercially available, is used in place of acidified water as a vehicle for acid fluxes. Tests show that the poly-

WERNER



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How can you produce a better looking control panel escutcheon at lower cost? For HARMON KARDON, aluminum extrusions were punched, anodized, and silk screened to provide a practical answer for less money. Escutcheons had been made of molded plastic and were expensive and subject to cracking and discoloration. They also lacked the distinctive sales appeal which they deserved.

Werner engineers studied the problem — helped to design suitable extrusions and worked out details for producing a finished part ready for assembly. Werner aluminum extrusions can help you cut assembly costs on radios, appliances, television and Hi-Fi units. Write today or, better yet, send us prints and specifications. Werner engineers will be glad to work with you.

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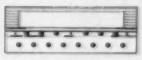

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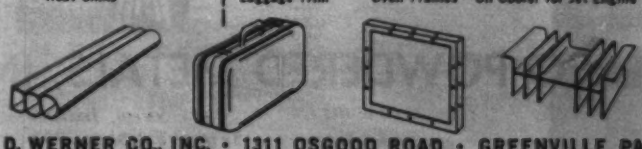

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Salem, Indiana
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ethylene glycol flux does not cause corrosion after the flux has been left standing on steel for a few days; water fluxes cause severe rusting and corrosion of metal after standing for a few days.

The residue of the new flux is liquid after soldering and can be easily washed away with warm water.

Polyethylene glycol performs well as a vehicle for such soldering fluxes as hydrazine hydrochloride and bromides, organic amine hydrochlorides and acidified resinous fluxes, as well as the commonly used zinc chloride.

Decorative Laminate Is Easy to Apply

A decorative laminate based on diallyl phthalate (DAP) resin has been developed by Food Machinery & Chemical Corp., Chemicals & Plastics Div., 161 E. 42nd St., New York 17.

Big advantage of the laminate: it can be applied with presses exerting 100-250 psi. Melamine and phenolic laminates require pressures up to 1000 psi.

Properties, uses

The new laminate is expected to be used on such wood products as

***Scouring powder** does not affect the surface of DAP laminate after 10,000 cycles of testing on a Gardner straight-line washability and abrasion machine.*

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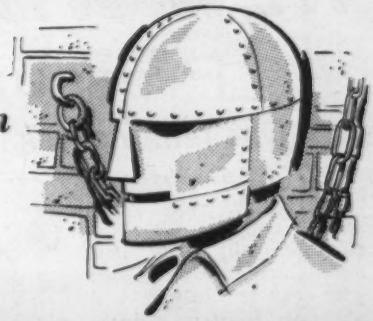
flexibility of design

INSUROK®



one of our 52 grades would have done the job better.

Main Characteristics and Advantages: INSUROK is non-corrosive, remarkably strong and durable, readily machinable, chemically-inactive, highly dielectric, non-hygroscopic, and resists moisture and heat. Usually it requires no additional protective or decorative finish. It is half the weight of aluminum and a fifth the weight of steel.

Proven-In-Use Applications: Presently being used for countless mechanical, electrical and chemical applications. Specifically—gears, bearings, couplings, rods, tubes, sheets, terminal boards, control pulleys, variable resistors, insulation, printed circuitry and other fabricated parts.

Bonus Advantage: The Richardson Company offers you a complete and integrated plastics service from research and design through fabricated products of all sizes and shapes.

Availability: INSUROK is available in a wide variety of grades, sizes, thicknesses in sheets, rods and tubed and fabricated parts. New grades are constantly being developed for new or improved products.

If you have a challenging product application, rely on the man from Richardson to help solve your problem. Write or phone for further information and catalogs today.

THE RICHARDSON COMPANY

FOUNDED IN 1858

2703 LAKE STREET, MELROSE PARK, ILLINOIS

CHICAGO PHONE: MAnsfield 6-8900 • SUBURBAN PHONE: Fillmore 4-4300

Laminated Fabricated and Molded Plastics

For more information, turn to Reader Service card, circle No. 411

Announcing...

NEW NYLAFLOW®

Pressure Hose

One-fifth the weight and Outperforms Rubber Hose of Equivalent Burst Strength

• A specially formulated nylon inner tube reinforced with high tensile yarn and abrasion resistant cover*, make new NYLAFLOW pressure hose ideal for jobs requiring exceptional resistance to *flex*, pressure pulse and vibrational fatigue.

It is unaffected by flammable and non-flammable hydraulic fluids, hydrazine and other rocket fuels, and has excellent resistance to caustics and almost all organic solvents. Freon permeability is approximately 1/10 that of rubber hose. Excellent non-conductor for use around high voltage power lines.

Odorless, non-toxic, non-corrosive, fungus resistant and will not embrittle in storage. Functions efficiently over wide temperature range (—65°F. to +250°F.). Remains form stable but can be permanently heat-formed to small, stress-free bend radii.

NYLAFLOW Pressure Hose with burst pressure ratings of 5000 and 8000 psi., is available in long continuous lengths in standard diameters up to ½". Compact, lightweight, reusable fittings and assemblies are also available.

NYLAFLOW Pressure Tubing in sizes up to ⅜" O.D., with burst pressure ratings of 1000 and 2500 psi., is used for lower pressure requirements in applications such as lubrication, hydraulic, pneumatic, fuel and oil or beverage lines. It is flexible for easy installation and can be attached with standard flare or compression fittings designed for metallic tubing.

For full information, write for booklets on hose and tubing.

*Patented

The Polymer Corporation of Penna.

Reading, Pa.

POLYPENCO

For more information, turn to Reader Service card, circle No. 493

table tops, vertical wall panels and cabinets. It can be laminated to plywood, gypsum board, particle board, asbestos-cement board and hardboard.

According to the developer, the laminate has good resistance to chlorine bleaches, nail polish and boiling water. It is also resistant to fire and cigarette burns.

KEY NO. 632

Ferroelectric Ceramic Useful up to 600 F

A line of high temperature ferroelectric ceramic parts for use in sonar systems, hydrophones, ultrasonic cleaners, accelerometers and similar electro-acoustical devices is commercially available from Universal Dynamics Corp., Div. of Acoustica Asso., Inc., 130 Los Aguajes Ave., Santa Barbara, Calif.

Big advantage of the new parts is that they are made of a modified "lead zirconium titanium" material called Michelite that is said to maintain its piezoelectric properties at temperatures up to 600 F, compared to other ferroelectric ceramics that are useful only to 212 F.

The producer says the ceramic compound is also suitable for operation from room temperature down to cryogenic temperatures.

Typical Michelite shapes include hollow spheres and cylinders up to 6 in. in dia. and bars up to 1 ft in length; also disks and blocks. Parts are formed to close tolerances and are polarized under controlled laboratory conditions. Ends of the parts are silver coated for easy attachment of leads. KEY NO. 633

Acrylic Moldings Have High Impact Strength

Three high impact acrylic molding powders have been introduced by Rohm & Haas Co., Washington Sq., Philadelphia 5. The three grades, designated Implex B, C and F, join Implex A acrylic molding powder introduced two years ago (see M/DE, Sept '57, p 208).

B is said to provide good surface gloss for quality retail items such

Only one of sixty materials met these tough filter specifications

Troyfelt, a non-woven synthetic Dacron, gave best performance in military vehicle engine.

The specifications? Ability to produce nearly 100% filtering efficiency in heavy dust conditions, in temperatures from -65 to 275°F, resistance to oil, moisture, rot and mildew. The product? The filter on a heavy duty engine intake air cleaner on a military vehicle. The result? Out of sixty materials tested, only one, TROYFELT, did the job.

The secret behind TROYFELT'S success is its specialized manufacturing process of mechanically interlocking the Dacron, Orlon and other special synthetic fibers rather than chemically binding them or introducing binder fibers. This method eliminates the old filter "bugaboo" of blinding caused by such binders or binding agents and gives TROYFELT its unusually high, long-lived strength, excellent resistance to fungi and bacterial growth, chemicals, moisture, oil, abrasion, stability to temperature extremes and many others.

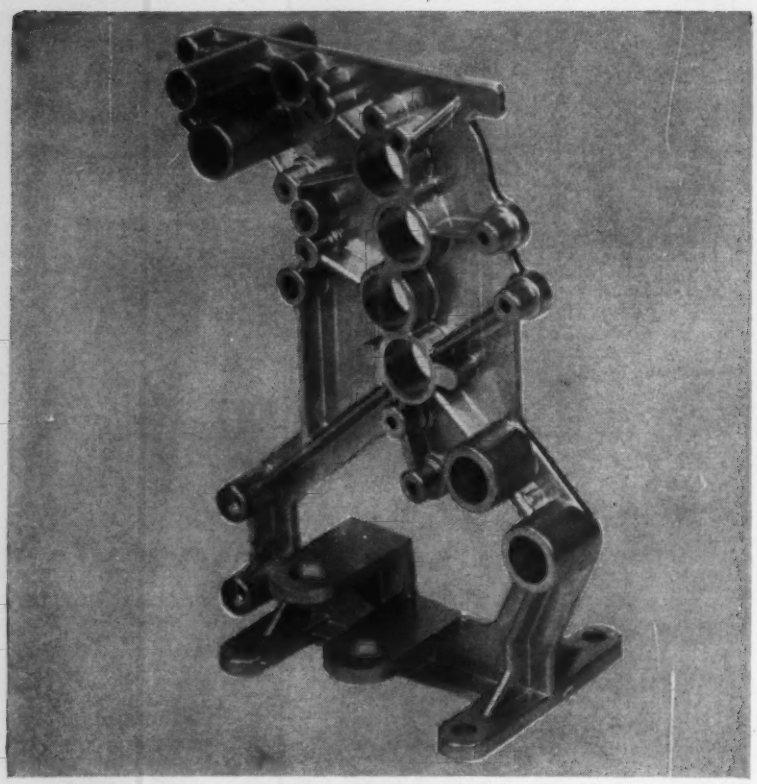
But, filtering is only part of the TROYFELT story — other applications for this remarkable material include insulators, seals, padding, packings, gaskets and many others. We'll be glad to send you our bulletin describing most of them and samples.

TROYFELT ... *by the pioneers in non-woven synthetic felts*

INDUSTRIAL PRODUCTS DIVISION • TROY BLANKET MILLS

200 Madison Avenue • New York 16, New York

For more information, turn to Reader Service card, circle No. 503



What other process could do it so well?

All things considered, there's really only one *best* way to produce this typical die casting application.

When you figure that it must be built at the lowest possible unit cost, must use a production method that is highly flexible to accommodate the unusual shape, and must maintain a variety of close tolerances . . . only die casting *could* do the job.

Working closely with Twin City engineers, this manufacturer *designed* for die casting to get the maximum out of the process. By thinking in terms of die casting right from the drawing boards he eliminated many production and finishing jobs, saved on unit costs, saved on machining.

Possibly you're producing a part by some more costly, less flexible, less accurate process than die casting. If you think that might be true, contact Twin City Die Castings Company. Twin City engineers can probably save you money. They have for hundreds of customers.

. . . only DIE CASTING can
✓ cut your costs
✓ offer such flexibility
✓ provide such accuracy

FOR PROOF . . . CALL, WRITE OR WIRE:

TWIN CITY DIE CASTINGS CO.

3351 TALMAGE AVENUE S. E. • MINNEAPOLIS 14, MINNESOTA
TELEPHONE MIDWAY 6-7528

DIE CASTING RESEARCH FOUNDATION PARTICIPANT

For more information, turn to Reader Service card, circle No. 497

What's new IN MATERIALS

PROPERTIES OF ACRYLIC POWDERS

Type →	B	C	F
PHYSICAL PROPERTIES			
Specific Gravity	1.16	1.18	1.16
Flammability, ipm	0.5	0.6	0.7
Mod Shrinkage, mil/in.	4-8	4-8	4-8
Flow Temp, F	295	285	325
Water Abs (24 hr), %	0.3	0.3	0.3
MECHANICAL PROPERTIES			
Ten Str, psi	7300	7600	8000
Elong, %	25	15	25
Flex Str, psi	11,500	12,000	12,000
Impact Str (Izod notched), ft-lb/in.	0.8	0.5	0.8
Compr Str, psi	10,500	11,500	12,000
Rockwell Hardness	L89	L93	L94
Heat Dist Temp (264 psi), F	174	174	189

as housings for electric razors.

C provides good stain resistance in applications such as piano and organ keys.

F provides good heat resistance in applications such as beverage vending machine canisters.

(For information on the properties and uses of other impact thermoplastics, see M/DE, Nov '59, p 123.)

KEY NO. 634

Aluminum Foil, Sheet for Decorative Uses

Four new aluminum products for decorative uses are now on the market. They are: 1) adhesive coated-aluminum foil that can be bonded to a variety of materials; 2) a group of decorative, three-dimensional aluminum sheets; 3) embossed aluminum alloy sheet in which the pattern is highlighted in color; and 4) wider painted aluminum coils than previously available.

The first two products, adhesive coated-foil and three-dimensional sheets, are available from Aluminum Co. of America, 734 Alcoa Bldg., Pittsburgh 19.

The other two products, coated coil and embossed aluminum alloy sheet, are available from Kaiser Aluminum & Chemical Corp., 300

NEW MATERIAL.. NEW PRODUCT.. MOLDED IN PLASTICS BY

GENERAL AMERICAN

To the raw material manufacturer it was a new plastic with built-in high impact and temperature characteristics, plus high resistance to degrading ultra-violet rays.

To General American, it was a challenge—a problem of finding a suitable user for the plastic and then developing special techniques to mold the material.

The result is the handsome outboard motor hood shown here—the first injection-molded hood ever produced in plastics.

General American, with the nation's foremost molding facilities, investigates every promising new material in order to keep ahead of customer needs. Its engineers and craftsmen are supported by over fifteen years, experience in all fields important to the development of new products in plastics.

You can be sure that if a part or a product can be molded in plastics, General American can mold it for you. You'll find in this field, as in many others, *it pays to plan with General American.*

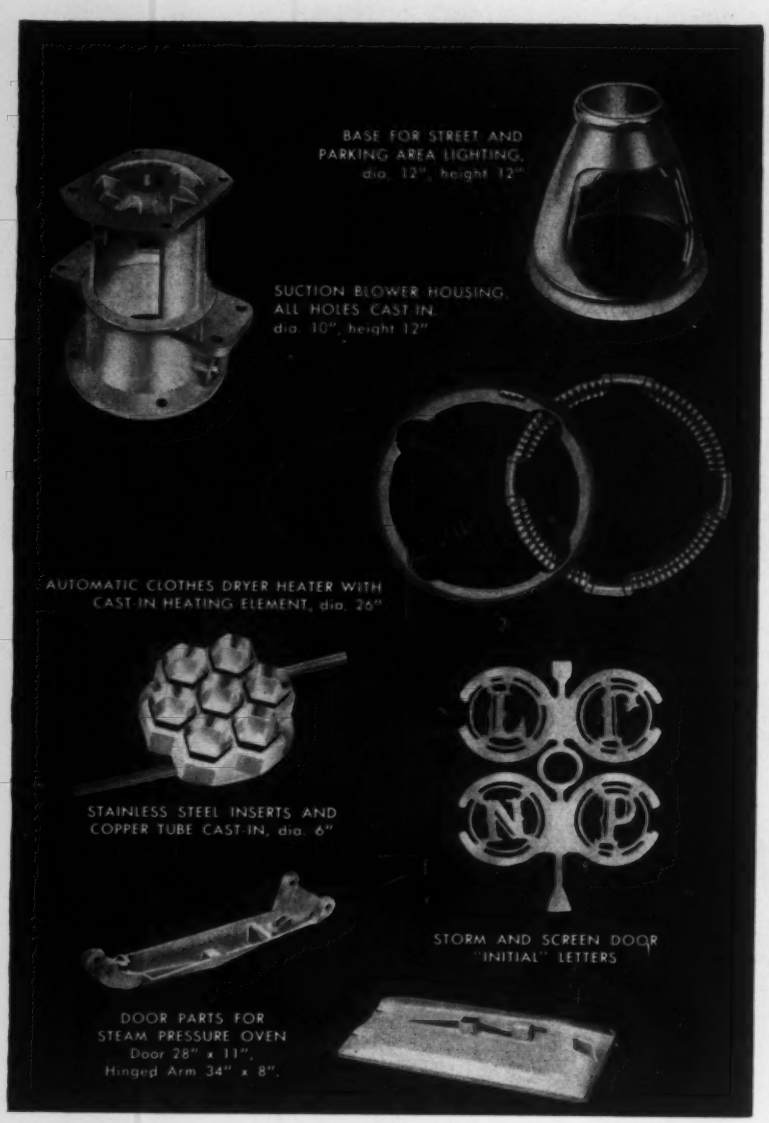
Plastics Division

GENERAL AMERICAN TRANSPORTATION CORPORATION

135 South LaSalle Street
Chicago 3, Illinois

PLASTICS DIVISION GENERAL AMERICAN TRADE MARK

For more information, turn to Reader Service card, circle No. 518


BASE FOR STREET AND PARKING AREA LIGHTING. dia. 12", height 12"
SUCTION BLOWER HOUSING. ALL HOLES CAST IN. dia. 10", height 12"
AUTOMATIC CLOTHES DRYER HEATER WITH CAST-IN HEATING ELEMENT, dia. 26"
STAINLESS STEEL INSERTS AND COPPER TUBE CAST-IN, dia. 6"
STORM AND SCREEN DOOR "INITIAL" LETTERS
DOOR PARTS FOR STEAM PRESSURE OVEN Door 28" x 11". Hinged Arm 34" x 8".

ALUMINUM
PERMANENT MOLD
CASTINGS

evaluate today
progress tomorrow

The method of casting that assures density, homogeneous structure, with surfaces that take a high finish. Illustrated castings indicate how other metals are cast with aluminum to meet specific performances. For more ideas and recommended applications, write for new brochure. Our permanent mold engineers will be happy to work with you.

Exalco MANUFACTURING CO.
46 SHELDON ROAD • BEREA, OHIO • BEREA 4-2091

For more information, turn to Reader Service card, circle No. 353

Whatsnew IN MATERIALS

Lakeside Dr., Oakland 12, Calif.

1. Adhesive coated-foil

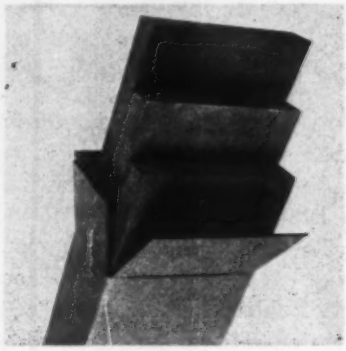
Alcoa's adhesive coated-aluminum foil can be bonded under heat and pressure to plastics, plywood and other wood products.

The coated foil is supplied in thicknesses down to 0.001 in., and in widths up to 50 in. It can be supplied coated on one or both sides.

Alcoa says the product's versatility has been demonstrated by successfully bonding it to hard and softwood lumber, veneers and plywood; to tempered and untempered hardboard, flakeboard, chipboard and particle board; and to phenolic and melamine-impregnated kraft paper.

The product is expected to find use in the following applications:

Furniture veneers: The Fine Hard-



Plastics planks for patterns— The plastics planks shown above are designed to replace mahogany, and impregnated and laminated wood as pattern and model making materials. The planking, called Ren Wood and available from Ren Plastics, Inc., 5422 S. Cedar Rd., Lansing 9, Mich., is supplied in standard lumber sizes of 1 ft wide by 6 ft long and in thicknesses of 2 and 2½ in. Big advantage of the plastics planking is that it does not warp. Exposure of plastics planking to 100% RH at 100 F for three days resulted in a swelling of no more than 0.020 in. per ft in any direction. According to the developer, up to 10 to 20% of mahogany is often unusable for construction of master models because of warpage and grain imperfections.

KEY NO. 636

the LEAD newsletter

Vol. 2 No. 1

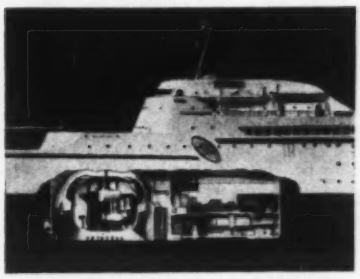
As modern as tomorrow, lead is playing an essential role in the harnessing of nuclear energy.

Improved Reactor Design

A mixture of lead pellets and organics is used by the Atomics International Division of North American Aviation in the three layer shield of their L-77 and L-47 reactors. Important savings in weight and cost are achieved by using lead's neutron reflector properties as well as its gamma shielding abilities.

The inner region of the shield is a lead pellet-diphenyl mixture. This reduces gammas and reflects or moderates escaping neutrons. The middle layer, of borated paraffin, further moderates thermal neutrons. Finally, a mixture of lead pellets and paraffin functions as the outer shield.

Advantages of mixtures of lead and organic materials: lead reflects neutrons, improving neutron economy; it reduces radiation damage of organics by absorbing energy; it absorbs secondary gamma radiation emitted by neutron capture; finally, compared to laminated lead and paraffin, the mixture has a higher thermal conductivity and specific heat, allowing higher operating temperatures without hot spots.



First Nuclear Merchant Ship

The N.S. Savannah . . . first nuclear-powered merchant ship . . . uses lead, combined with less dense shielding materials, to contain the radiation within the power plant. Lead is an ideal material . . . it can be subjected to gamma radiation and nuclear bombardment *without becoming radioactive.* Aboard the Savannah, it is effectively used in combination with water, concrete, and polyethylene to reduce weight and bulk.

"Modified Swimming Pool" Reactor

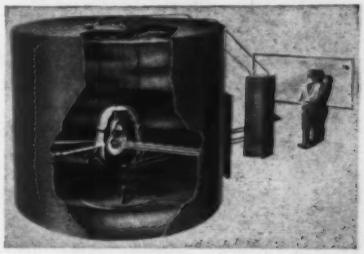
At the Naval Research Laboratory in Washington, D. C., over 20 tons of lead were used in constructing the radiation shield of a "modified swimming pool" research reactor. Designed to meet the needs of a variety of investigations in the physical sciences, the reactor provides the intense source of neutrons and gamma rays required in the laboratory's research programs. One end of the pool is a heavy lead and concrete radiation shield which includes several beam ports with removable plugs. To keep the shield thickness to a minimum, lead with its high density was a natural choice. In addition to providing efficient shielding against gamma radiation, lead *absorbs* a portion of the gamma ray and fast neutron energy entering the shield. This keeps the temperature in the surrounding concrete shield at a minimum and prevents the moisture content of the concrete from being driven off.

Beta Gage Measurements

Continuous, precise measurements of mass or density can radically improve both cost and quality of many products. These measurements are now being attained by the Beta Gage which senses the effects of mass on a radiation beam. Lead plays three important roles in this testing: it is a shielding material to protect the external surfaces of the instrument from stray radiation; it is used as a radiation beam collimator; and it is further, a "target" in generating a second type of radiation.

Isotope Utilization

The newly-constructed Cities Service Research and Development Co. Laboratory at Cranford, New Jersey, is conducting experiments on the effects of radiation on refinery processes and products. A three-pound supply of Cobalt 60, transported there in a 6,000 pound lead pig, is kept prisoner by a 12 inch lead door weighing 30,000 pounds. It can be observed through a 42 inch leaded window weighing 7,500 pounds. This 12 inch lead door provides the same effective barrier to the 5,000 curies of radiation generated by the Cobalt 60 as do the 42 inch, high-density, concrete walls which form the other three walls of the cave.



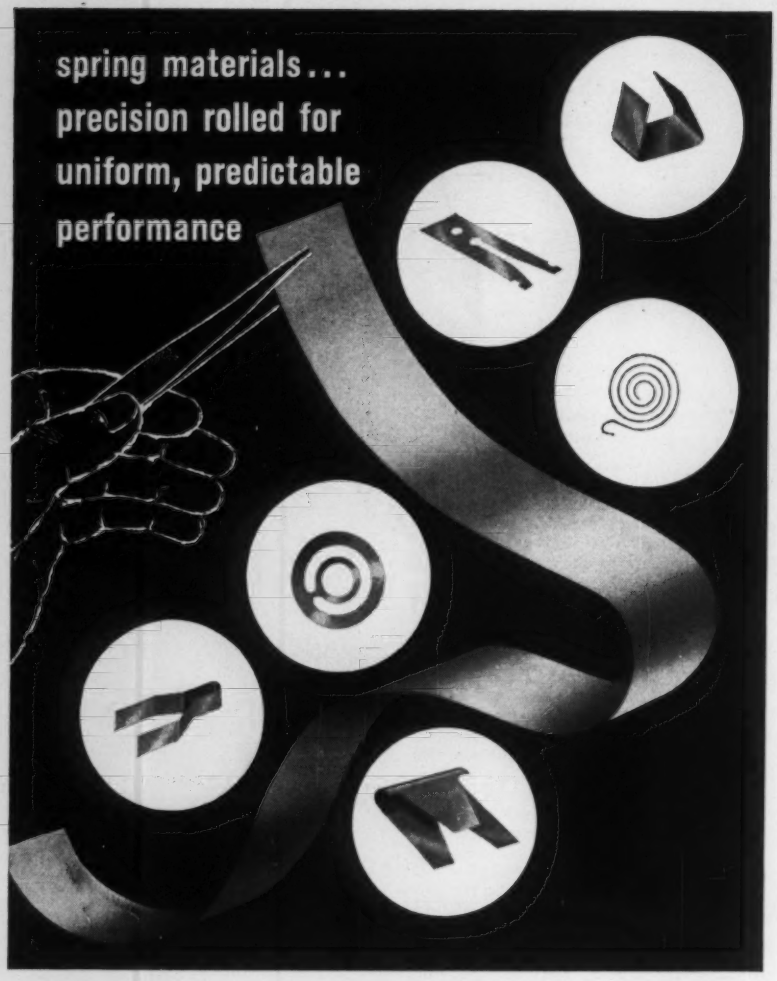
Commercialized Atomic Power

In Southern California Edison's Sodium Reactor Experiment (SRE), located about 30 miles northwest of Los Angeles, the reactor, designed to produce about 20,000 kw. of heat . . . which will be converted into approximately 6,500 kw. of electricity . . . is now operating at full power. Lead is employed to provide a safe, mobile means for loading uranium fuel . . . for removal of any hot elements penetrating the reactor core . . . and for transporting them to cleaning, storage, or hot cell facilities located in the reactor building. American International Engineers, who built the SRE, also designed and built a small 5-watt laboratory reactor for use in school, medical, and industrial laboratories. They took advantage of lead's unusual properties in employing it as a reflector shield in the reactor.

Lead is available in or can be fabricated to almost any form required to solve radiation shielding problems. In sheet, bricks, castings, extrusions, powder, pellets or shot, alone or in combination with plastics or other materials – lead is able to perform conveniently and economically. Write Lead Industries Association, 292 Madison Avenue, New York 17, N. Y. 2348

LOOK AHEAD WITH LEAD

For more information, turn to Reader Service card, circle No. 375



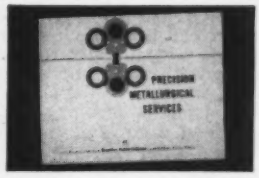
Here—from Precision Metals Division of the Hamilton Watch Company—are important new spring materials. Now available in production quantities are flat wire and metal strip of Beryllium Copper, Elinvar, Havar, Stavar, Inconel Extra and Age-Hardening Stainless Steel.

The newly expanded and completely integrated Precision Metals Division is producing these spring materials with these unusual advantages:

thicknesses from .010" to .0001"
extremely close tolerances
dimensional uniformity

controlled metallurgical properties
excellent surface characteristics

In addition, Precision Metals Division will also furnish special alloys to your own specifications in the particular form you require. Write today for a copy of facilities booklet DE-5 or mail your prints for proposal.

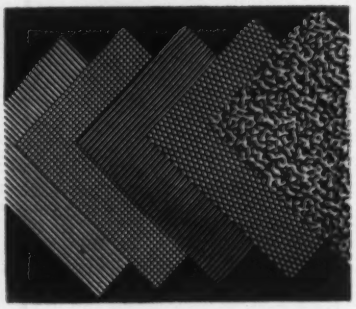


HAMILTON
WATCH COMPANY / **Precision Metals Division**
Lancaster, Pennsylvania

Representatives
COREY STEEL COMPANY • Chicago, Illinois
FAGERSTA STEELS PACIFIC, INC. • Los Angeles, California

For more information, turn to Reader Service card. circle No. 500

What's new IN MATERIALS



***Patterns** available in new aluminum sheet product introduced by Kaiser Aluminum & Chemical Corp.*

woods Assn. recently approved Alcoa's new product for use under face veneer of hardwood furniture panels because the foil produces a veneer that is cigarette-burn-proof and highly resistant to heat. The underlying layer of foil, approximately 0.0025 in. thick, dissipates heat from a lighted cirgarette quickly enough to prevent scorching of the wood fibers and damage to the surface finish.

Paint base: According to Alcoa, plywood can be upgraded by applying foil to one or both sides of plywood as a paint base. The foil will take a long lasting, grain-free finish, thus increasing the versatility of the plywood.

Light reflector: In its unpainted form, foil-sheathed plywood could be used to increase the efficiency of lighting equipment by utilizing the foil's reflective qualities.

The producer says that plywood covered with the new foil meets the shear strength and moisture resistance requirements of Commercial Standard CS45-55 for Douglas fir plywood interior grade.

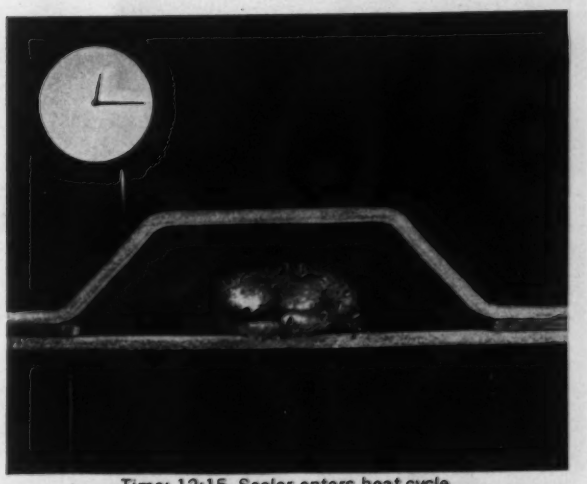
The foil also meets National Electrical Mfrs. Assn. (NEMA) standard LP2-1957 for cigarette-proof plastics laminates. **KEY NO. 637**

2. Three-dimensional sheets

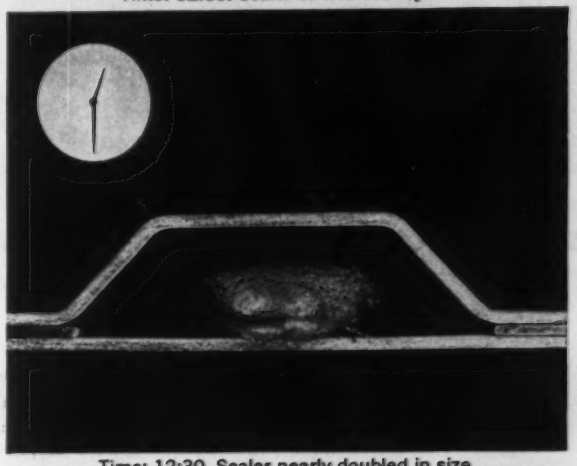
Alcoa's new group of decorative, three-dimensional aluminum sheets is available in four designs: alternately raised and depressed pyramids, a flat-top perforated design, a round perforated design, and a large vented design. The sheets measure 4 by 8 ft. **KEY NO. 638**

(continued on p 244)

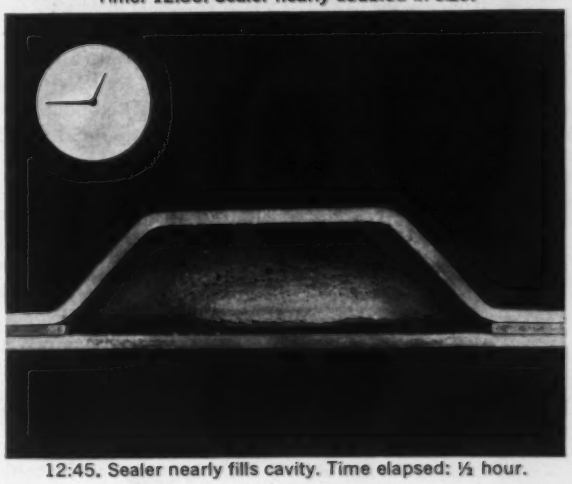
Positive way to seal irregular gaps and seams—3M Heat Expandable Sealers



Time: 12:15. Sealer enters heat cycle.



Time: 12:30. Sealer nearly doubled in size.



12:45. Sealer nearly fills cavity. Time elapsed: ½ hour.

You can simplify tough sealing jobs of irregular gaps and seams with 3M Heat Expandable Sealer EC-2117. When heated this liquid will expand 150% in volume and cure to a solid sponge rubber material to tightly fit the shape of the seam, affording a weather-tight, water-tight, dirt-tight seal.

EC-2117 is designed to expand and cure to a resilient sponge-like rubber which will adhere to most surfaces. It can also function as a weld-thru sealer which does not alter normal spot welding procedure, nor interfere with weld quality. EC-2117 adheres well to both clean and oily surfaces. Use it wherever irregular openings must be filled, or where seam width is not constant.

Let 3M Adhesives, Coatings and Sealers help speed your production, improve product quality. For free information, write on your company letterhead to: AC&S Division, 3M Company, Dept. SBHH-50, St. Paul 6, Minnesota.

ADHESIVES, COATINGS AND SEALERS DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

. . . WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

For more information, turn to Reader Service card, circle No. 446

14 WAYS THE SILICONES MAN HAS HELPED AMERICA'S MOBILE MILLIONS

Silicones are now used to improve the quality, durability and operation of many of today's automobile parts. They also aid in many of the production processes. Tires slip easily from intricate molds coated with silicone release agents. So do rubber floor mats and radiator hose. Silicones are used in making shell molds for crankshafts, camshafts, and valves. Damped with silicone fluid, dashboard instrument needles stay steady over bumps. Silicone rubber sparkplug boots resist water, ozone, high heat for tens of thousands of miles longer. Electrically conductive silicone rubber ignition wire cores can reduce car radio interference. Silicone fluids save power by cutting out the radiator fan at high speeds. The actual foaming of polyether cushioning used in seats, arm rests and crash pads is closely controlled by silicone surfactants. Curiously, silicones also *prevent* foaming of rubber latex used for carpet backing. Beneath many cars, silicone rubber gaskets seal in hot transmission fluids, and prevent leakage of oil from differentials. Outside your car, silicones are the leveling agents for acrylic lacquer. They're all-weather lubricants for weatherstripping, giving longer wear and better moisture resistance. And they're the vital ingredients that make car waxes quick and easy to apply and polish. All this for just one industry. Is your business getting the most out of silicones? If not, call the UNION CARBIDE Silicones Man. Silicones Division, Dept. EM-0001 Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y.

Unlocking the secrets of silicones

Rubber, Monomers, Resins, Oils and Emulsions

UNION CARBIDE

SILICONES

The term "Union Carbide" is a registered trade-mark of UCC. *In Canada:* Bakelite Company, Division of Union Carbide Canada Limited, Toronto 7, Ontario

For more information, turn to Reader Service card, circle No. 519

3. Color-embossed sheets

Kaiser's color-embossed aluminum alloy sheet is produced by a new method (complete details have not been revealed) in which dissimilar aluminum alloys are combined and fabricated into sheet with embossed patterns. The patterns are stucco, diamond, ribbed and square.

When the sheet is anodized by the customer, its pattern is highlighted in color.

The new sheet is expected to be used as trim in automobiles and appliances, and in office equipment.

It is supplied in gages from 0.030 through 0.064 in., in flat or coiled form up to 36 in. wide. KEY NO. 639

4. Wide painted coil

Kaiser-Kote is the name of the coated aluminum coil which is available in widths from 2 to 66 in., and in thicknesses from 0.006 to 0.064 in. Previously, the coated coil was available only in widths up to 42 in.

The product is supplied in a variety of colors, and is coated with the newest types of paints, according to Kaiser.

Potential uses for the coated coil are awnings, license plates, residential siding, and panels for house trailers. KEY NO. 640

Vinyl Plastisols Used for Coating, Molding

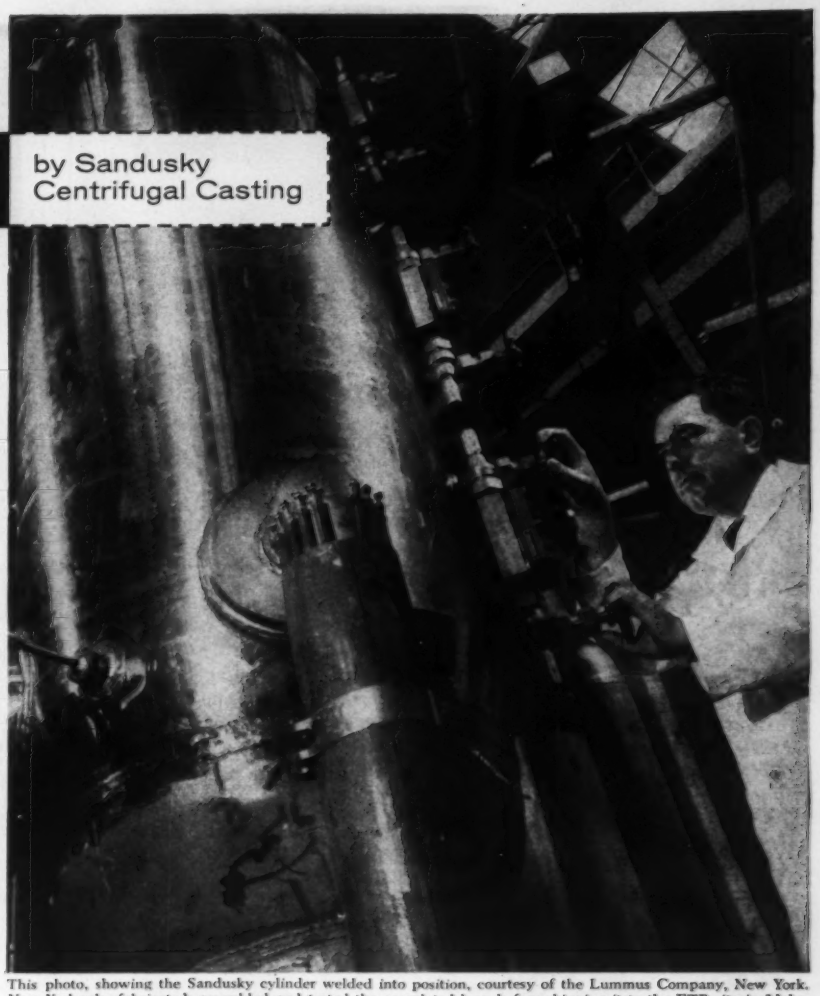
Two vinyl plastisol formulations and a modifier for vinyl plastisols have recently been introduced. The two plastisols are designed for hot dip coating of metal parts, and for rotational and slush molding.

1. Plastisol formulations

The plastisol formulations were developed by Dennis Chemical Co., Inc., 2701 Papin St., St. Louis 3. One formulation, called Denflex No. 9218, is said to have excellent dimensional stability, high tensile strength, good electrical properties, and good impact resistance. It is recommended for use as a hot dip coating on tool handles, as a slush molding compound for rigid displays, and as a rotational molding compound for toys and novelties.

The other new plastisol formulation is called Denflex No. 9184. It is

SOLVED: by Sandusky Centrifugal Casting



This photo, showing the Sandusky cylinder welded into position, courtesy of the Lummus Company, New York. New York who fabricated, assembled and tested the completed loop before shipping it to the ETR site in Idaho.

Nuclear Test Loop Uses Sandusky Centrifugal Casting as Pressurizer Cylinder

A Sandusky Centrifugal Casting is the main cylindrical component of an electrically heated pressurizer, designed by Knolls Atomic Power Laboratory to Section VIII, of the ASME Code (Unfired Pressure Vessels) for use in the new Engineering Test Reactor facilities at Idaho Falls, Idaho.

This 66¼" long cylinder, 27" O.D. with walls 2½" thick, was centrifugally cast of an 18-8 stainless steel (SA-351, Grade CF-8) for the extra corrosion resistance required under nuclear loop service conditions: demineralized water at temperatures to 650°F and pressures to 2500 PSI.

O. G. Kelley Co., Boston, to whom we delivered this 2-ton, fully machined cylinder, welded on the forged heads and nozzles, radiographed the welds, and hydro tested the completed vessel to 4300 PSI.

This is another example of the adaptability of Sandusky Centrifugal Castings to applications demanding the highest order of quality. They may well offer you a practical and economical answer to your cylindrical needs, also.

We are producing cylinders and piping in diameters from 7" to 54"—in lengths to 33 ft.—in a wide range of ferrous and non-ferrous alloys. Write for Bulletin 300, for more complete technical information on the Sandusky process and product application data.

SANDUSKY CENTRIFUGAL CASTINGS
FOUNDRY & MACHINE CO.

SANDUSKY, OHIO—Stainless, Carbon, Low-Alloy Steels—Full Range Copper-Base, Nickel-Base Alloys

3903

For more information, turn to Reader Service card, circle No. 393

Tempilstik°

*temperature indicating crayons**

Tempilstik°—a simple and accurate means of determining preheating and stress relieving temperatures in welding operations. Widely used in all heat treating—as well as in hundreds of other heat-dependent processes in industry. Available in 80 different temperature ratings from 113°F to 2500°F . . . $2.00 each.

Send for free sample Tempil° Pellets. State temperature desired . . . Sorry, no sample Tempilstiks°

Most industrial and welding supply houses carry Tempilstiks° . . . if yours does not, write for information to:

INDUSTRIAL DIVISION

Tempil° CORPORATION
132 West 22nd St., New York 11, N. Y.

*Also Tempil° Pellets and Tempilaq° (liquid form)

For more information, circle No. 402

What's new IN MATERIALS

PROPERTIES OF DENFLEX NO. 9184

PHYSICAL PROPERTIES	
Solids Content, %	100
Specific Gravity	1.213
Viscosity (77 F), cps	2500
Light Stability	Good
Viscosity Stability at Temp below 85 F	3 mo
MECHANICAL PROPERTIES	
Tensile Strength, psi	2000
Elongation, %	350
Low Temp Flexibility	OK at -30 F
Wear Index on Taber Abraser (1000 cycles), mg loss[a]	14

[a]Wear test conducted with CS-17 wheel at 1000 gm.

said to have good electrical insulating properties (see table for other properties). The compound can be used as a hot dip coating on metal parts, and as a casting compound. A typical use would be a coating for tools used in electrical work.

KEY NO. 641

2. Plastisol modifier

The vinyl plastisol modifier is available in experimental quantities from Rohm & Haas Co., Resinous Products Div., Washington Sq., Philadelphia 5. Called Monomer X-970, the material is described as a high boiling, low viscosity ester that is polymerized by heating and/or catalysis.

According to the developer, the modifier imparts fluidity to plastisols, yet polymerizes to a hard polymer during the plastisol fluxing cycle. The developer says the modifier is ideally suited for use in rotational and other closed-mold applications. It is said to produce harder castings with reduced tendency to deform under heat than castings made with conventional plastisol formulations.

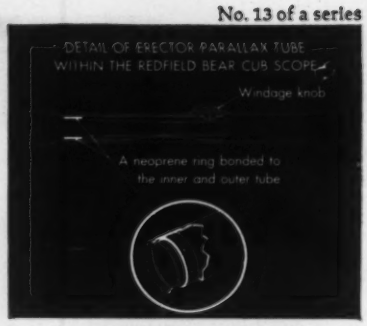
KEY NO. 642

Refractory Material Withstands 3000 F

Asbestosite is the name given to a new refractory material (composition not revealed) that is said to withstand continuous exposure to temperatures from 1000 to 3000 F.

According to the developer, Harco Laboratories, Inc., New Haven, Conn., the material also has good thermal shock resistance. In addi-

No. 13 of a series


DETAIL OF ERECTOR PARALLAX TUBE WITHIN THE REDFIELD BEAR CUB SCOPE
Windage knob
A neoprene ring bonded to the inner and outer tube

Eastman 910 Adhesive solves another production bottleneck

Ames Rubber Company, of Hamburg, New Jersey, assembles the erector parallax tube for the Redfield Gunsight Company's "Bear Cub Scope," a precision telescopic rifle sight.

In it, two concentric aluminum tubes are bonded to a neoprene ring.

Vulcanizing the ring in place required complex jigs, long curing times. Labor and material costs were high. Concentricity tolerances were frequently exceeded, with a resulting high rejection rate.

Fast-setting, high-strength Eastman 910 Adhesive solved their problem. *Now the part is assembled in 2 minutes, goes to the shipping room within 5 minutes.*

Over 50,000 units have been produced with no reports of bond failure.

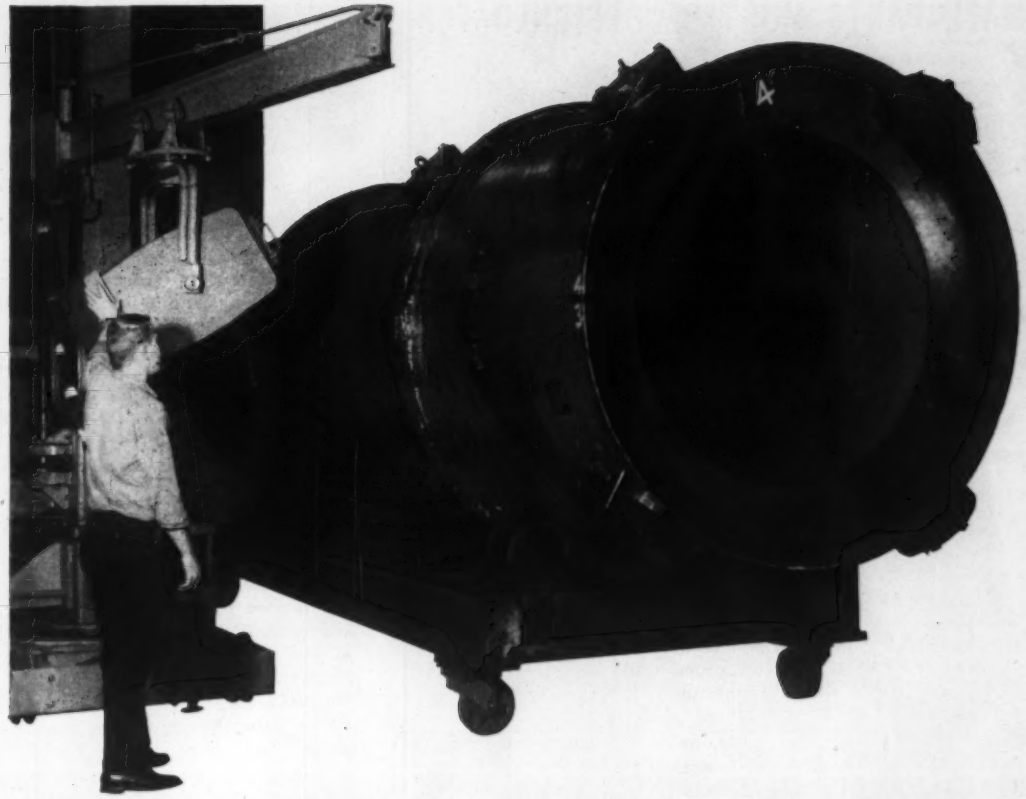
Eastman 910 Adhesive is making possible faster, more economical assembly-line operations and new design approaches for many products. It is ideal where extreme speed of setting is important, or where design requirements involve joining small surfaces, complex mechanical fasteners or heat-sensitive elements.

Eastman 910 Adhesive is used as it comes. No mixing, no heating. When spread into a thin film between two surfaces, light manual pressure triggers setting. With most materials, strong bonds are made within minutes.

What production or design problem can this unique adhesive solve for you?

For a trial quantity (⅓-oz.) send five dollars to Armstrong Cork Co., Industrial Adhesives Div., 9105 Dunbar Street, Lancaster, Pa., or to Eastman Chemical Products, Inc., Chemicals Div., Dept. E-5, Kingsport, Tenn. (Not for drug use)

For more information, circle No. 420



Undersea nest for a talented metal bird

This is the firing tube of the Navy's Polaris missile, made by Consolidated Welding and Engineering Company, Chicago, Ill. Every weld must be flawless. To make sure, more than 100 radiographs are made on each assembly.

Made of HY-80 plate with monel inserts, this firing tube presents difficult problems in welding dissimilar metals. But radiography, with Kodak Industrial X-ray Film, Type AA, checks the entire assembly for discontinuities.

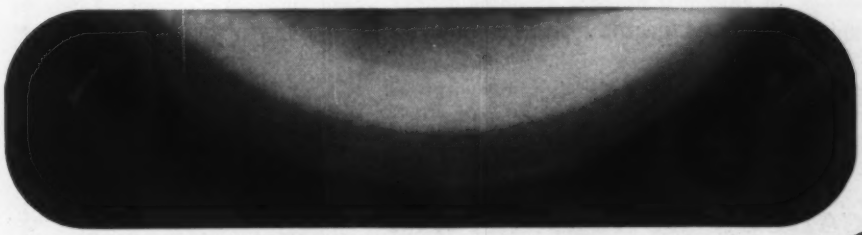
Radiography provides the means of "seeing" internal conditions and supplies a lasting record of what is seen. It gives producers of welded products and of castings a means of making sure only high-quality work is delivered.

Would you like to know how radiography can help you? See an x-ray dealer or write us to have a Kodak Technical Representative call.

Read what Kodak Industrial X-ray Film, Type AA, does for you:

- Speeds up radiographic examinations.
- Gives increased detail visibility and easy readability at all energy ranges . . . because of high film contrast.
- Provides excellent uniformity.
- Reduces the possibility of pressure desensitization under shop conditions.

EASTMAN KODAK COMPANY
X-ray Division, Rochester 4, N. Y.



Radiograph of weld on missile firing tube.

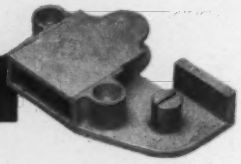
Kodak
TRADE MARK

For more information, turn to Reader Service card, circle No. 421

For more information, turn to Reader Service card, circle No. 480

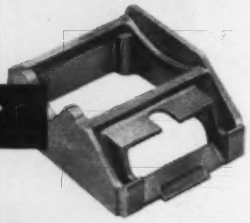
WHEN SMALL PARTS MUST BE DESIGNED FOR

STRENGTH



OPC casts eight different STURDY bronze alloys.

LIGHT WEIGHT



OPC casts six different LIGHTWEIGHT aluminum alloys.

ELECTRICAL CONDUCTIVITY

OPC casts beryllium copper for GOOD conductivity, and for the strength of steel, after heat treating.

Clean, smooth and accurate within close tolerances, OPC castings have helped solve small parts design and production problems in just about every industry.

OPC will work right from your blueprints and deliver the finished product —10 or 10,000—on schedule and correct to your specifications.

OPC customers just don't have small parts design and production problems . . . and you shouldn't, either. Let OPC show you why.

OPC

PLASTER MOLD CASTINGS—Brass, Bronze, Aluminum, Beryllium Copper

OHIO PRECISION CASTINGS, INC.

109 Webb St. Dayton 3, Ohio

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HAVE YOU EXPLORED GRAPHITE As A Problem-Solving Material?

Are you looking for an economical substance that combines machineability, chemical inertness, high thermal conductivity, high temperature stability, resistance to thermal shock, corrosion resistance?

Are you looking for a material that has proved to be highly suitable for such diverse applications as vital nuclear reactor components, molds and dies for metals casting, sintering boats and trays, run-out tables and canisters, refractories, brazing fixtures, linings in chemical process equipment, thermocouple shields, and electric resistance furnace parts?

May we have the opportunity of helping you solve your materials design problem with some of the finest graphite being produced today by one of the largest graphite producers in the world?

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For more information, turn to Reader Service card, circle No. 351

tion, it is easy to fabricate into a wide variety of shapes and sizes.

Market studies show the new material has potential use in automotive and aircraft exhaust systems, in rocket constructions, and in piping applications where liquids are to be transferred at extremely high temperatures. KEY NO. 643

Compound Retards Static Electricity

Static electricity in plastics films and molded products, and in paper and synthetic textiles, can be retarded with a new compound introduced by Statikil, Inc., 1220 W. 6th St., Cleveland 13.

The compound can also be used to reduce static electricity in machinery, carpeting, phonograph records, instruments and photographic equipment. One important application is its use on plastics bags to keep them from adhering to children's faces.

The compound is supplied in pressurized cans at $3 a can, or in bulk at $15 per gal. KEY NO. 644

Glass-Base Premix Is Track Resistant

A glass-base premix molding compound joins a previously available polyester-glass laminate that features excellent track resistance. The molding compound and the laminate, which was introduced late last year (see M/DE, Dec '59, p 152), are both available from Glastic Corp., 4321 Glenridge Rd., Cleveland 21.

Parts made of the new molding compound, like parts made of the laminate, can be used in electrical apparatus operating in dust-laden and humid atmospheres. A present application for the premix compound, called Resistrac, is electrical insulating parts for 5000 and 15,000-v switchgear.

Glass-base parts might replace mica, ceramic parts

According to Roger S. Jackson, Glastic's chief engineer, ". . . parts made of the new molding compound can serve as stronger, less bulky replacements for ceramic or glass-

R B & W FASTENER BRIEFS

MAKING THE MOST OF MODERN MECHANICAL FASTENING

Technical-ities

By Fred E. Graves

Fastening of gasketed joints

The right fastener for a "flexible" joint rests on type of gasket material and its compressibility. Total preload on all the fasteners in the connection must be enough only to compress the gasket and provide sufficient additional clamping force to withstand the hydrostatic test pressure. More than this brings on a good chance of leakage, through "bowing" of the clamping plate.

Exaggerated sketch showing how too much torque tends to distort clamping plate and leads to leakage.

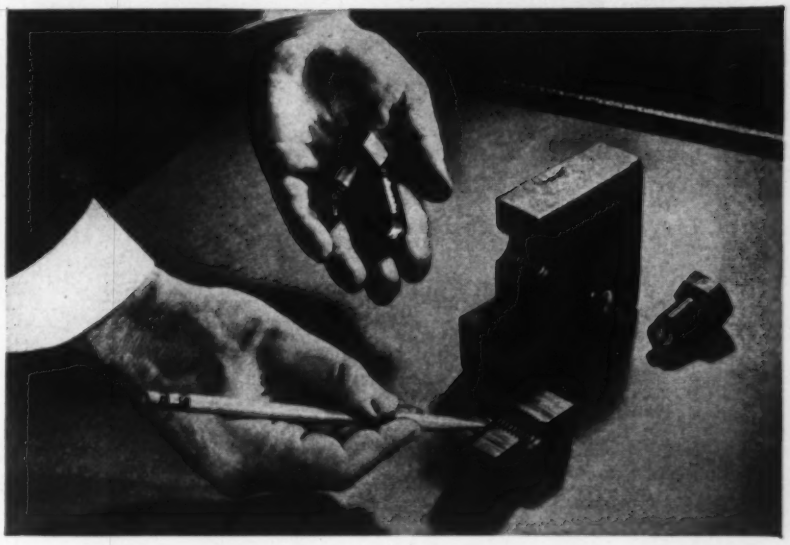
HYPOTHETICAL CASE

Suppose a joint is tightened with Grade 5 Hex Screws to their yield strength, and leakage develops. By going to alloy screws and tightening still further you would still get leakage. But Grade 2 Hex Screws, all torqued evenly, would no doubt solve it.

ACTUAL CASE

The fasteners on one product's flange had to withstand a 4000 pound hydrostatic pressure. But the hard asbestos gasket used took a bolt load of 28,000 pounds for sufficient compression to seal. By substituting a rubber and fibre gasket in this case, bolt load could be reduced. So could bolt size, thereby saving 73% on fasteners.

Using Hex Screws in tapped holes saves money



In the cast "coupon" shown above, the hex screws were torqued tight and removed 50 times—then torqued to failure. Note in the cutaway that the casting's threads are still perfect with no sign of stripping. It was the screws which broke—a clear demonstration that castings fastened with hex screws will suffer no thread damage during repeated disassemblies.

TWOFOLD BENEFIT

When there are no space clearance problems or other special requirements, using studs of 1-inch diameter or smaller often penalizes the user. First, in direct costs, since the more economical hex head screws will do the job to specification. And second, in production costs, since studs require that tapped holes have an *interference* thread fit, which in turn results in slow, "selective" assembly to determine properly mated threads. Hex screws need only a *clearance* fit, assemble faster.

ACTUAL EXAMPLE

In one of his surveys of fastenings used by one company, the RB&W engineer pointed out that over 250 stud fastenings were being used in a large refrigeration unit. The same number of hex screws, costing $8.45, saved $22 over the studs and nuts. Annually, the total would be $7,800 on the production run of this unit.

Not to be overlooked either was the tangible saving on the less critical tapping job required.

RB&W offers its help on your specific fastener problems, or an overall survey of your fastener usage. Contact Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N. Y.

Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. **Additional sales offices at:** Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

For more information, turn to Reader Service card, circle No. 366

STRAITS TIN REPORT

News of developments in the production and uses of tin

MALAYAN TIN BUREAU

Rubber tin—A tin compound that stretches like rubber and can be vulcanized has been developed by the Army. Tin is substituted for carbon, the usual base of rubber. The new polymer, alkyl tin methacrylate, is a "stretchable" high-temperature material with greater resistance to chemical fuel than conventional rubber. This may lead to a series of carbon-replacement materials similar to boron chemical fuels.

New tinplate that is lighter, stronger and thinner than any ever made is being researched by major steel producers. It shows great promise and is expected to offer important economic advantages to canners and other tin plate users, for shipping and product protection. No change in tin content of the new plate is indicated.

Nonspattering flux is the result of experiments by Tin Research Institute. The new soldering process uses polyethylene glycol instead of acidified water as a vehicle for acid fluxes. It has a low boiling point—flux won't spatter when it contacts molten solder or soldering bit. Spreads smoothly over large area. Won't rust or corrode; residue washes off easily. Low volatility prevents evaporation; high flashpoint eliminates fire risk. No unpleasant odors or harmful fumes.

Write today for more data on these items or for a free subscription to TIN NEWS—a monthly bulletin on tin supply, prices and new uses.

The Malayan Tin Bureau
Dept. 24E, 2000 K Street, N.W., Washington 6, D.C.

For more information, circle No. 331

What's new IN MATERIALS

PROPERTIES OF RESISTRAC PARTS[a]

PHYSICAL PROPERTIES	
Specific Gravity (molded)	2.2
Shelf Life (85 F), days	30
Water Absorption (24 hr), %	0.4
Mold Shrinkage, in.	0.002-0.004
MECHANICAL PROPERTIES	
Tensile Strength, psi	5,000
Flexural Strength, psi	14,000
Compressive Strength, psi	18,000
Impact Strength (Izod notched), ft-lb/in.	3-6
Flame Retardance, sec ignition/ sec extinguish[b]	90/30
ELECTRICAL PROPERTIES	
Dielectric Strength, v/mil	300
Arc Resistance, sec	180
Track Resistance, hr[c]	400

[a]Tests performed on 1/16-in. thick specimens.
[b]Test performed in accordance with Federal Specification LP 406B.
[c]Test performed on ¼-in. thick specimens under proposed ASTM dust-fog track resistance test.

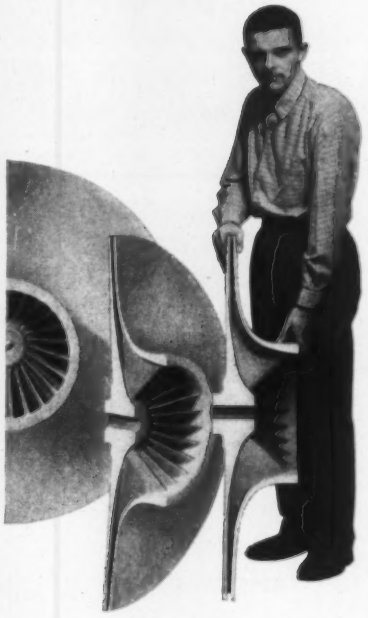
bonded mica parts in many indoor electrical applications."

Reason: intricate shapes can be molded from the compound, and these shapes are strong because of the glass fiber reinforcement.

Track resistance

Jackson says track resistance of ¼-in. thick specimens molded of the compound is 200-750 hr, as measured by a proposed ASTM dust-fog track resistance test. This value represents several years service under the most adverse environ-

***Electrical insulator** made of polyester-glass premix molding compound, although eroded, is said to be functionally sound after testing 480 hr under a proposed ASTM dust-fog track resistance test.*



Large aluminum impellers cast smooth and accurate with metallurgical quality for high speed applications are among the specialties of Morris Bean and Company, Yellow Springs 1, Ohio.

BEAN

aluminum
magnesium
ductile iron
foundries

For more information, circle No. 445

To prevent corrosion and anchor paint on aluminum

ask Oakite

OVER 50 YEARS CLEANING EXPERIENCE • OVER 250 FIELD SERVICE MEN • OVER 160 MATERIALS

Protect aluminum at lowest unit cost with CHROMICOAT® conversion coating

Oakite CHROMICOAT is an economy any way you look at it: on the basis of price alone . . . on solution make-up and "mileage" . . . on the way it blocks corrosion and forms a perfect anchor for paint to keep your customers sold and satisfied.

This is a conversion coating you can depend on. Oakite ChromiCoat protects for hundreds of hours under the ordeal of salt-spray tests . . . and surpasses MIL-C-5541 specs *several times over!*

And the Oakite process is simplicity itself. No control problem. A thin, golden, uniform coating every time.

ChromiCoat is just one of a line of more than 30 Oakite materials designed especially for aluminum. There are etch and non-etch cleaners . . . barrel finishing compounds . . . safe paint strippers . . . forming lubricants.

For more information, ask your local Oakite man or write to Oakite Products, Inc., 17 Rector Street, New York 6, N. Y.

it PAYS to ask Oakite

OAKITE

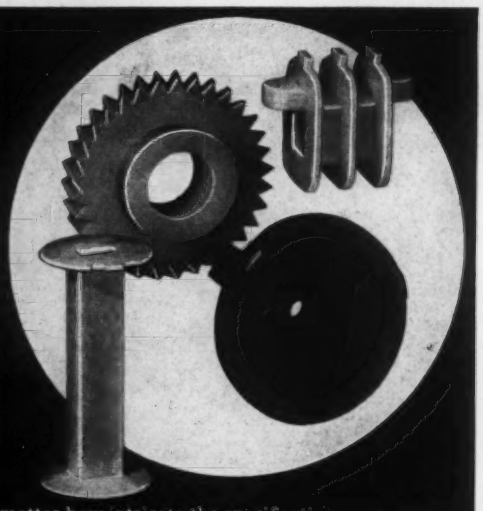
over 50 Est. 1909 SCIENCE

years' leadership in industrial cleaning

For more information, turn to Reader Service card, circle No. 382

For more information, turn to Reader Service card, circle No. 357

LOOKING FOR *QUALITY* PLUS *ECONOMY* IN MOLDED PLASTIC PARTS?



No matter how intricate the specifications, our master craftsmen can design and produce a low-cost plastic product of superior quality to meet your size and quantity requirements. Special facilities also available to work out your production problems. Write us today! All inquiries receive our prompt and interested attention.

custom molders of the unusual

STANDARD PLASTICS Company
INCORPORATED

NEW YORK OFFICE 303 FIFTH AVENUE TEL. MURRAY HILL 6-0327
MAIN OFFICE AND FACTORY 60 WATER STREET TEL. 1-4040
ATTLEBORO, MASS.

mental conditions, Jackson says.

In the proposed ASTM test, a specimen is coated with an artificial dust containing flint, clay, salt and paper. The specimen is placed in a chamber and sprayed with water. An electrical charge of 1500 v is applied between two electrodes placed 1 in. apart on the surface of the specimen. Arcing between the electrodes produces high temperatures in the material which may cause carbon tracking. Materials are rated by the time required for the arcing to form a conductive carbon path between the electrodes.

Conventional thermosetting plastics usually track to failure in 10 to 20 hr in the proposed ASTM test.

According to Jackson, an arcing attack on ceramic parts usually creates a thermal shock that may crack, chip or spall the ceramic parts.

KEY NO. 645

NEW NYLON & THERMOPLASTIC PARTS from GRC

Economically mass produced on fully automatic patented machines, GRC nylon parts are available from stock in many sizes and types. GRC uses single cavity techniques, molds in one automatic cycle, gets accurate, uniform parts, ready for immediate use.

These advantages, these economies, apply too, to tiny made-to-order parts to your specifications . . . in quantities of 25,000 to many millions. Write for bulletin describing GRC's unqiue method for injection molding small plastic parts or send for prints for quotation. Ask about our zinc alloy die castings, too!

NO SIZE TOO SMALL
Maximum size 1¼" long—.03 oz.

NYLON SCREWS & NUTS

GRC's complete line of high quality, close tolerance molded nylon screws and hex nuts include screws in standard commercial heads—Phillips or slotted types—in sizes from #4 thru ¼"; hex nuts in ten sizes (#2 thru 5/16") GRC molded nylon miniature machine screws—half the weight of aluminum—in sizes from #2 thru ¼" make more compact designs possible. GRC's single cavity molding technique adds exceptional uniformity, accuracy, economy to nylon's high strength-to-weight ratio, built-in electrical insulating qualities, stability, resilience and elasticity. GRC's molded nylon fasteners are available from stock in a wide range of types, sizes and lengths.

WRITE, WIRE, PHONE NOW for your copy of GRC's new detailed Industrial Fastener Catalog

GRIES

25 years of progress in tiny parts

GRIES REPRODUCER CORP.
World's Foremost Producer of Small Die Castings
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See us at the DESIGN ENG. SHOW—Booth #2435

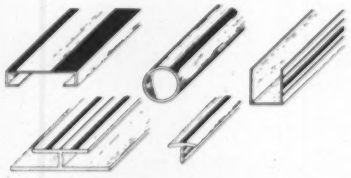
For more information, turn to Reader Service card, circle No. 423

Plastics Extrusions Are Multicolored

Multicolored plastics parts are the result of a new extrusion process developed by Anchor Plastics Co. Inc., 36-36 36th St., Long Island City 6, N. Y. Details as to how the process works have not been revealed.

According to the producer, the multicolor extrusion process can turn out parts such as radio and appliance dial scales, cabinet and panel moldings, handles, pen barrels and decorative trim with two-tone effects.

Any combination of two opaque or translucent colors, or crystal clear and any color, can be specified. The producer says the second color

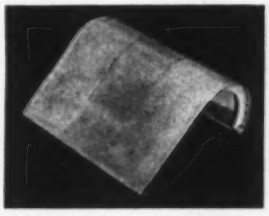


***Multicolored extrusions** are made in various shapes and sizes. The second color portion (indicated by black areas) is said to be an integral part of the extrusion.*

Report on Developments of

New Fansteel 82 Metal in Hypersonic Vehicle Prototypes

Design and development work on hypersonic flight vehicles by Boeing Airplane Company and other missile and airframe manufacturers has indicated some important use-possibilities for Fansteel 82 Metal. This new columbium-tantalum-zirconium alloy was among the materials fabricated into prototype leading edges for materials capability evaluations at 2000°F and over. Results verified Fansteel's own tests proving the metal's high strength-to-weight properties at elevated temperatures.

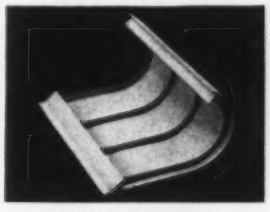


Excellent Oxidation Resistance

Exhaustive tests in the Fansteel laboratories prove Fansteel 82 Metal far superior in oxidation resistance to pure columbium. Calculated on the basis of weight gain during exposure at 2000°F in air, 82 Metal is ten times as resistant as the pure refractory metal. Sixteen-hour, 2000°F test in flowing air showed remarkable low scaling of 0.01 cm.

Tensile Properties of Sheet

The encouraging results of Boeing's prototype tests indicate 82 Metal's suitability for airframe and missile material. Average tensile properties are shown below.



Fansteel 82 Metal Easily Formed

In addition to its high temperature properties, 82 Metal has excellent fabricating characteristics. Ductile welds are made with little or no tendency to fracture in heat affected zones. It is easily fabricated at room temperatures, as worked or annealed. Its melting point is 4550°F and density 10.26 grams per cc (0.371 lb. per cu. in.).

TENSILE PROPERTIES OF SHEET

TEMPERATURE Degrees F	ATMOSPHERE	ULTIMATE TENSILE STRENGTH, psi.	YIELD STRENGTH .2% offset, psi.	ELONGATION % in 1 in.
70-80	Air	76,000	65,000	12
1800	Argon	59,000	53,000	1.5
2400	Argon	19,000	15,000	14

Welding the Boeing prototype in an inert atmosphere chamber using tungsten inert gas process.

Design and Engineering Help

Fansteel engineers and metallurgists are now working with many other firms in adapting Fansteel 82 Metal to specific areas. They will be glad to cooperate with your own designers and production people in studying and applying this useful new metal. Just send us your print or part sample, or call in the Fansteel representative.

Available From Stock

For experimental purposes . . . Fansteel 82 Metal is available from stock in ingots, forgings, bar, rod, plate and sheet. Let us keep you informed of developments concerning this new alloy as they occur. Write for the latest technical bulletin.

Photos Courtesy of Boeing Airplane Company

FANSTEEL

FANSTEEL METALLURGICAL CORPORATION

NORTH CHICAGO, ILLINOIS, U.S.A.

K602

For more information, turn to Reader Service card, circle No. 453

Art Wire specializes in wire forms designed for today's automatic production lines . . . manufactured with the precision and uniformity that assure the economy of an uninterrupted work flow. Reduced down-time, and the lower costs made possible by Art Wire's modern production methods mean greater savings to you, and greater profit in your operations.

ART WIRE AND STAMPING CO.
13 Boyden Place, Newark 2, N. J.

For more information, circle No. 399

What's new IN MATERIALS

portion is not a thin surface effect but is an integral part of the extrusion, several thousandths of an inch thick.

The multicolored extrusions, trademarked Twin-Tint, are made to customer specifications in most thermoplastic materials. **KEY NO. 646**

Other News . . .

Metals

▸ Belleville Wire Cloth Co., Inc., 135 Little St., Belleville, N. J. is supplying wire cloth that is said to be free of jagged or uneven edges. The wire cloth is available short or long in any width. **KEY NO. 647**

▸ Gold alloy strip in thicknesses down to 0.0005 in. and in widths up to 4 in. is available from Accurate Specialties Co., Inc., 37-11 57th St., Woodside 77, N. Y. **KEY NO. 648**

▸ An ultra fine, high resistivity nickel-base wire called Moleculoy is now available with a protective coating of polyester enamel. The developer, Molecu-Wire Corp., Scobeyville, N. J., says the coated wire has good abrasion and heat resistance, and increased dielectric strength. **KEY NO. 649**

▸ Small billets of stainless and alloy steels for precision investment casting are available from Dreifus Steel Corp., 8 Cynwyd Rd., Bala Cynwyd, Pa. The billets are available in over 30 different alloys. **KEY NO. 650**

Plastics & rubber

▸ A new pressure hose with a specially formulated nylon inner tube reinforced with high tensile strength yarn is now available from Polymer Corp. of Pa., 2140 Fairmont Ave., Reading, Pa. Known as Nylaflow, the hose is one-fifth the weight and has a wall thickness less than one-half that of rubber hose with equivalent burst strength. **KEY NO. 651**

▸ High-quality reprocessed polyethylene film is available in pellet form from Interplastics Corp., 120 E. 56th St., New York 22. Called Poly-Pellets, the reprocessed film can be injection molded, extruded or blow molded into a variety of products. **KEY NO. 652**

▸ Thin, cast acrylic sheets for use as dial facings are being produced by Cast Optics Corp., 123 Newman St., Hackensack, N. J. The sheets are supplied clear or colored in thicknesses ranging from 0.015 to 0.050 in. **KEY NO. 653**

▸ Connecticut Hard Rubber Co., 407 East St., New Haven 9, Conn. has introduced a Viton synthetic rubber sheet stock called Cohrlastic 975. The sheet measures 12 by 12 in. and 24 by 24 in., in thicknesses of 1/32 to 1/8 in. **KEY NO. 654**

▸ A series of synthetic rubber compounds for use in vibration damping applications at audio frequencies has been announced by Industrial Electronic Rubber Co., 31945 Aurora Rd., Solon 39, Ohio. The producer says the compounds can be fabricated into extremely small and complex shapes. **KEY NO. 655**

▸ Unarco U-200 is the name of a new rigid urethane foam pipe insulation specially designed for use at temperatures ranging from -300 to 200 F. The product is marketed by Union Asbestos & Rubber Co., Fibrous Products Div., 1111 W. Perry St., Bloomington, Ill. The urethane foam insulation is supplied in half-round sections and blocks. **KEY NO. 656**

▸ Two plastics laminates for use at 500 F have been introduced by Synthane Corp., Oaks, Pa. Grade ARF-HT consists of an asbestos mat reinforced with a modified phenolic resin binder; Grade G3-HT has a glass fabric reinforcement and a modified phenolic resin binder. **KEY NO. 657**

Other nonmetallics

▸ A kraft paperboard impregnated with a phenolic resin is a new product of Consolidated Paper Co., Monroe, Mich. The paperboard is produced in sheets up to 66 by 72 in., in thicknesses from 0.060 to 0.200 in. **KEY NO. 658**

▸ A new synthetic lubricant can be stored in tropical areas for five years or longer without deteriorating. The lubricant, developed by Esso Research and Engineering Co., 15 W. 51st St., New York 19, is recommended for use in jet planes. **KEY NO. 659**

▸ An SBR (styrene-butadiene) rubber-coated nylon diaphragm material for low temperature applications has been introduced by Reeves Bros., Inc., 1071 Ave. of the Americas, New York 18. The product, called Revecote 7331, is said to retain its flexibility at temperatures down to -67 F. **KEY NO. 660**

▸ Porter Engineering Co., 1513 W. Orvilla St., Hatfield Pa. is a new source for such pressed borosilicate glass products as light diffuser lenses, reflectors, oven windows, laboratory glassware and light fixtures. **KEY NO. 661**

▸ An improved Fosterite ceramic called AlSiMag 243 has been intro-

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What's new IN MATERIALS

duced by American Lava Corp., Manufacturers Rd., Chattanooga 5, Tenn. It is recommended for vacuum tube applications. **KEY NO. 662**

▸ A new latex-impregnated paper is designed as a wrapping material for metal stock during shipment. Sold under the name 259 by American Sisalkraft Corp., Attleboro, Mass., the paper resists abrasion caused by movement of a packaged load or by mechanical handling equipment. **KEY NO. 663**

▸ Electro-Thermal Industries, Inc., 57 S. Main St., Pearl River, N. Y. has added molybdenum and tungsten silicides to its line of heat and oxidation resistant materials. The silicides are supplied in cylindrical shapes and lumps. **KEY NO. 664**

▸ Two new silicone fluids, called XF 1030 and XF 1031, are compatible with a variety of fluids including aromatic and chlorinated hydrocarbons, aliphatic hydrocarbons and the lower alcohols. The fluids are available from General Electric Co., Silicone Products Dept., Waterford, N. Y. At 77 F, XF 1030 has a viscosity of 85 cs; XF 1031, 100 cs. **KEY NO. 665**

▸ Dawbarn Bros., Inc., Waynesboro, Va. has introduced a new polypropylene fiber designed for use in outdoor furniture. According to the developer, the fiber will not fade or lose its strength after exposure to outdoor weathering. The fiber is called DLP 55. **KEY NO. 666**

Finishes

▸ A liquid neoprene rubber paint called Apco has been developed by Adhesive Products Corp., 1660 Boone Ave., New York 60. The paint can be applied to metal, wood, plastics, concrete and other materials. It is self-vulcanizing and dries in a few minutes. **KEY NO. 667**

▸ Anton Co., 55 Front St., New York 4 is marketing a metal polish called Met-All that is said to clean and polish aluminum to a mirror-like finish. The polish can also be used on copper, brass, silver, stainless steel, pewter and gold. **KEY NO. 668**

▸ Electro Rust-Proofing Corp., P. O. Box 178, Newark 1, N. J. is offering an aluminum alloy anode for corrosion control in ocean-going ships. **KEY NO. 669**

▸ An ultrasonic cleaner for applications requiring high energy density has been developed by National Ultrasonic Corp., 111 Montgomery Ave., Irvington 11, N. J. The unit is called Model No. 220. **KEY NO. 670**

▸ Watco-Dennis Corp., 1640 20th St., Santa Monica, Calif. has introduced an oil and resin polymerizing finish for production prefinishing of wood. The material is said to achieve an oil or "Danish" type of finish without the hand rubbing usually required with linseed oil. **KEY NO. 597**

▸ An aluminum oxide insulating brick measuring 2½ x 4½ x 9 in. is available from Ipsen Industries, Inc., 715 S. Main St., Rockford, Ill. The specially formulated ceramic brick is said to withstand temperatures up to 3400 F. **KEY NO. 598**

Joining materials

▸ Silver-arsenic preforms with a melting point of 1800 F are designed for use in forming alloy junctions in semiconductor devices. The preforms are available from Accurate Specialties Co., Inc., 37-11 57th St., Woodside 77, N. Y. **KEY NO. 599**

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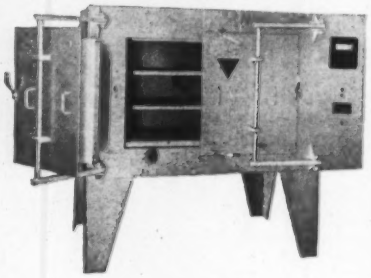

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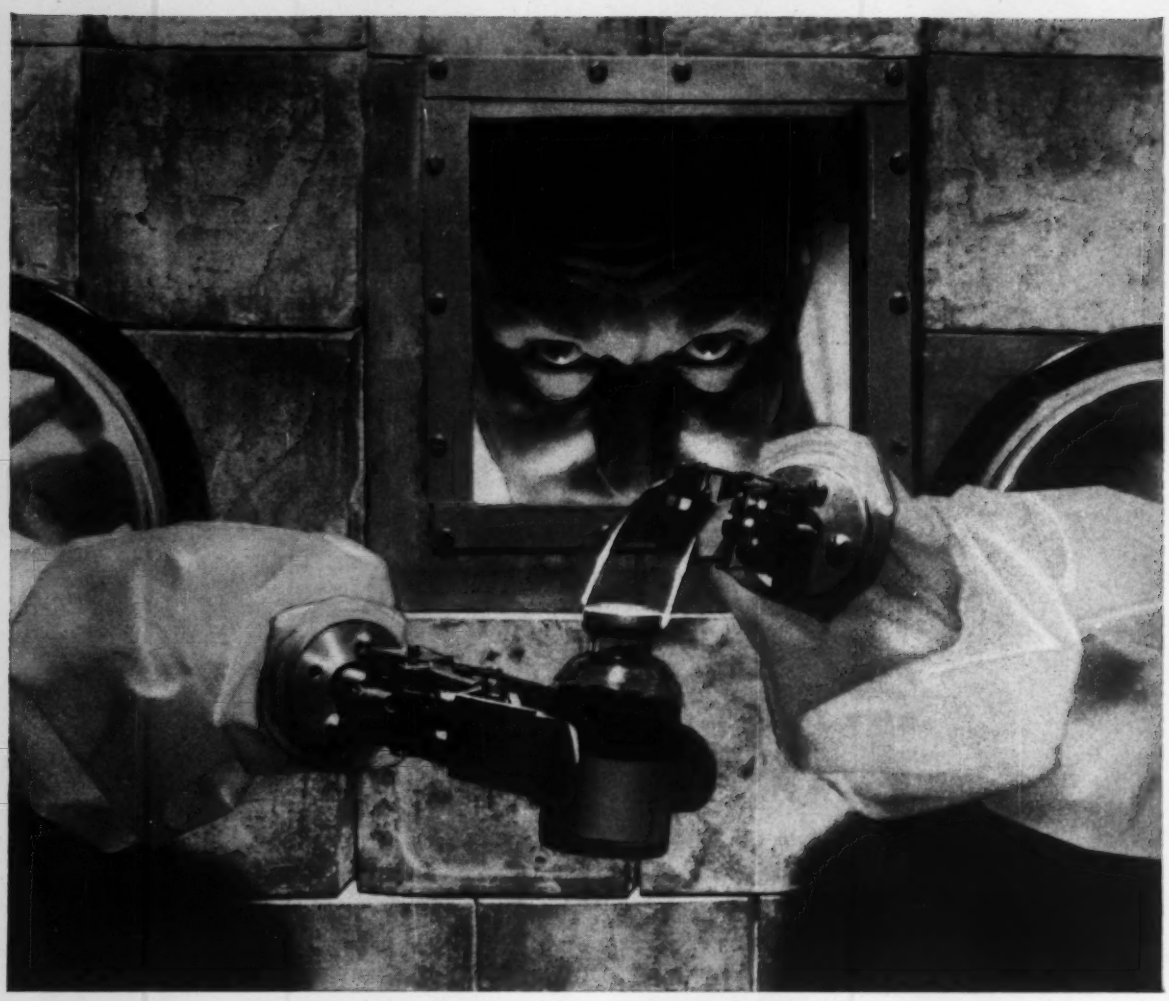

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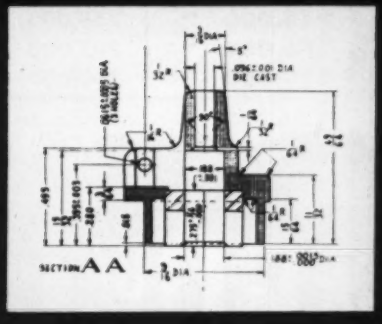

100 of these governors are die cast per hour.

Here is an excellent example of the design engineer's adjustment to the dictum: *In all business machines, space is at a premium.*

Used in a Burroughs desk-size adding machine, the miniature governor parts shown above had to be designed to fit into an extremely small space between the motor drive housing and the keyboard section. Consideration of the following factors led to the choice of zinc in the die cast design:

1. **HIGH SPEED OF PRODUCTION**
2. **ABILITY TO HOLD CLOSE TOLERANCES**
3. **STRENGTH AND DURABILITY**

The governors are cast in a two-cavity mold. After drilling and reaming the small holes, the parts are air-cleaned and assembled with steel pins and steel flyweights.

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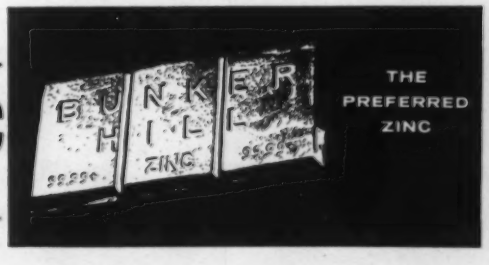

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COMPARE

SIZE	STANDARD HB	SPECIAL HB	MUSIC WIRE
.1620	219,000 min.	249,000 min.	249,000 min.
.1350	227,000 "	258,000 "	258,000 "
.0800	244,000 "	276,000 "	282,000 "
.0200	310,000 "	320,000 "	350,000 "

—at savings of up to 60%

You can use PAGE *Special* HB for many jobs where music wire has always been specified —and save up to 60% on your wire costs! PAGE *Special* HB is a hard-drawn, high-carbon steel wire, available in diameters from .162″ to .020″ (bright finish). Its tensile strength approaches that of music wire in all sizes — and in sizes .090″ and coarser equals it! Check the chart above for tensile strengths of four typical diameters. If you now use music wire, it makes sense to investigate PAGE *Special* HB; you may be able to reduce your wire costs considerably.

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Booklet DH-107A gives complete data on PAGE *Special* HB, including table of tensile strengths, chemical composition, dimensions, finishes, and other information. Write us at Monessen, Pa., for your copy —or for information on any other PAGE wire.

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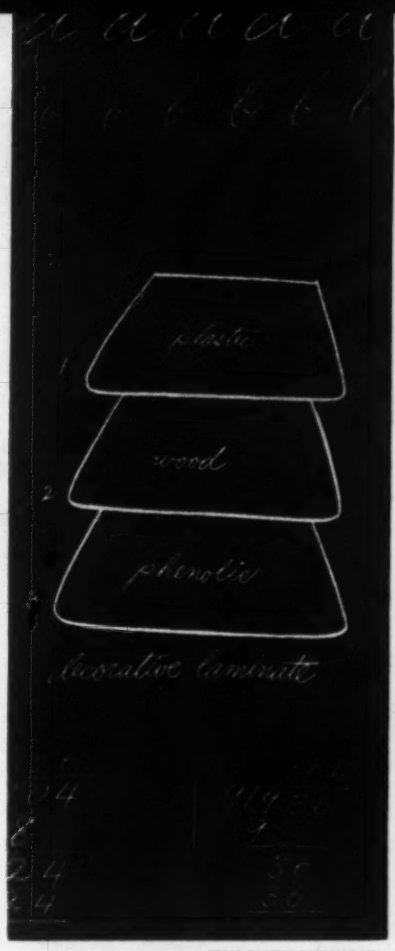

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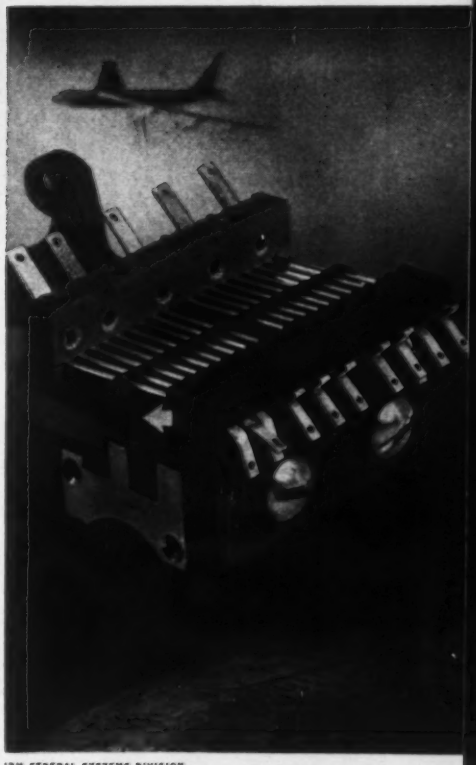

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For more information on Durez materials mentioned, check here:

- ☐ Phenolic molding compounds—descriptive Bulletin D400
- ☐ Phenolic resins—illustrated bulletin describing uses
- ☐ Diallyl phthalate molding compounds—data sheets

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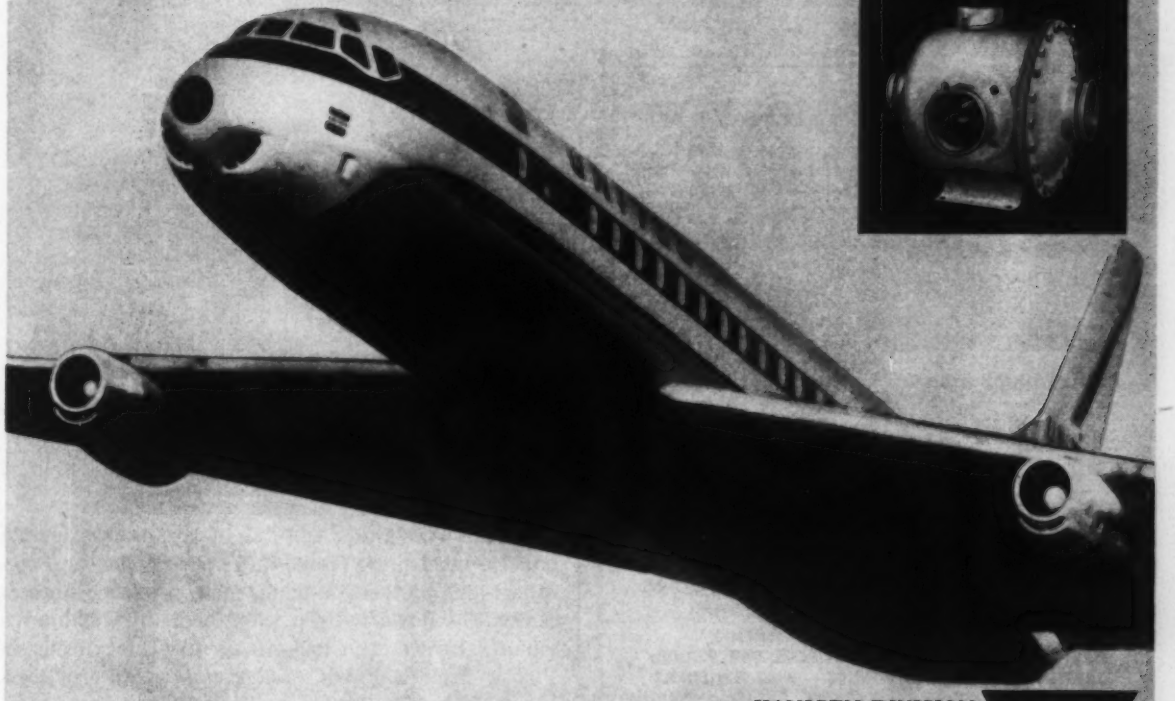

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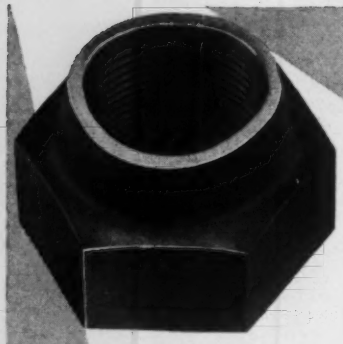

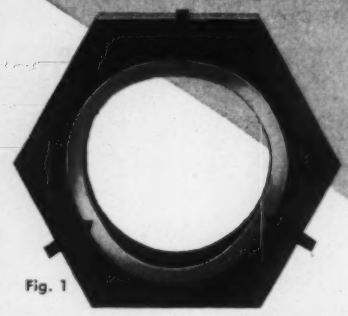

Fig. 1

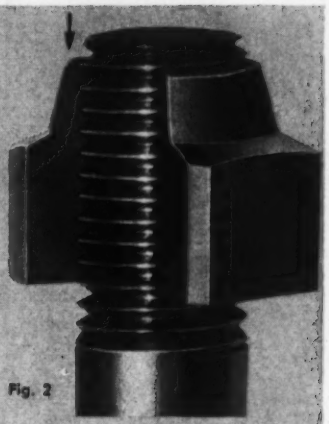

Fig. 2

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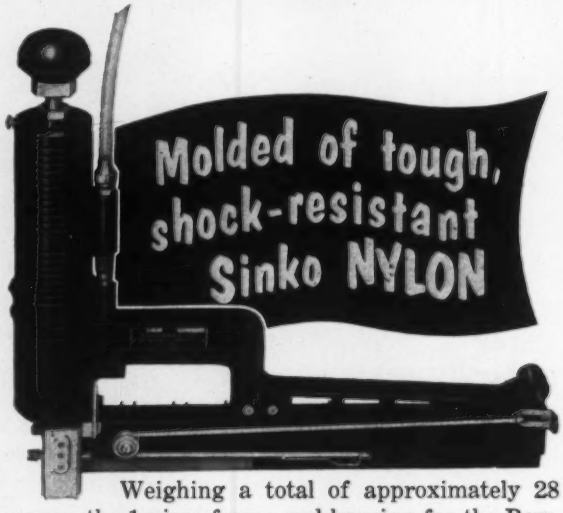

Weighing a total of approximately 28 ounces, the 1-piece frame and housing for the Powernail unit pictured is being mass produced here at Sinko. The Powernail Co. is one of many well known manufacturers who look to us for their needs in Plastic Molded Parts . . . *economically produced.*

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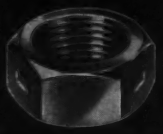
One piece all metal.



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With or without Gripco Lock. Countersink protects threads from weld spatter.

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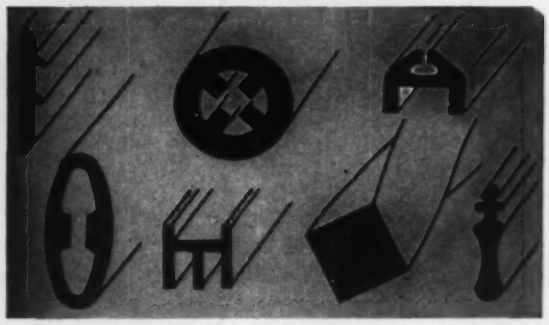

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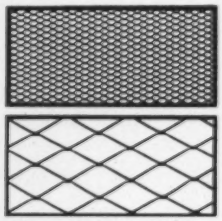

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Copper Alloy Bulletin

BRIDGEPORT BRASS COMPANY

new BRIDGEPORT NIRONZE® 635 gives 90,000 psi yield strength

90,000 psi Yield Strength Obtained with New Age-Hardenable Copper-Nickel-Silicon Alloy

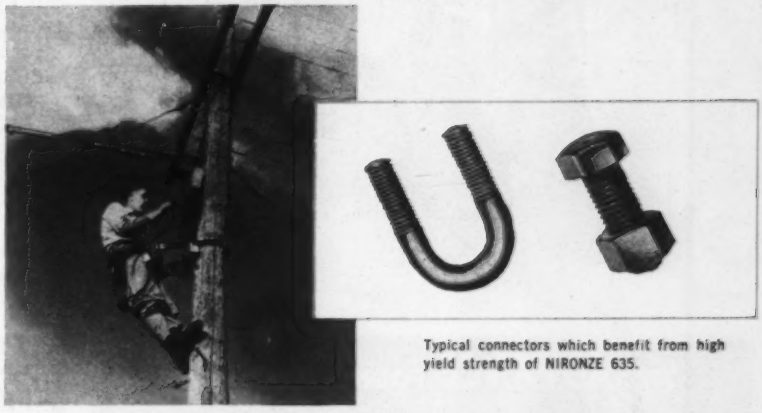
Bridgeport Nironze 635, an age-hardenable copper-nickel-silicon alloy, combines excellent cold-working properties with high tensile and very high yield strengths, good electrical conductivity, excellent general and stress-corrosion resistance. Supplied in the solution-treated and drawn condition, Nironze 635 offers exceptional cold-working properties. A low-temperature heat treatment, following additional cold-work age, hardens this alloy to produce tensile strengths of 100,000 psi, yield strengths of 85,000 psi and improved electrical conductivity of a minimum of 35% IACS.

Easily Cold-Formed... Machined

The excellent cold-working properties of Nironze 635 in the *solution-treated and drawn* condition allow such severe cold work as upsetting, cold-heading, roll-threading, bending, forming or similar operations to be carried out with ease. Heat treatment following this cold-work age-hardens this alloy to produce maximum tensile and yield strengths.

Nironze 635 in the *solution-treated-drawn-aged* condition has a machinability about 30% of free-cutting brass rod, thereby making it possible to carry out such conventional machining operations as sawing, grinding, turning, milling or similar operations.

Maximum cold-work may be performed on Nironze 635 in the *solution-treated* or soft condition. In order to obtain highest possible physical properties, this alloy must be cold-worked from 50-80% before aging.



Typical connectors which benefit from high yield strength of NIRONZE 635.

Proved by Performance in These Applications

Cold-headed bolts and fasteners used in pole line hardware, switch gear, wire connectors, neon signs, railway equipment, exposed electrical parts and structural supports, marine hardware and fittings can all use Nironze 635 to advantage. The new alloy's unique combination of high yield and tensile strengths, good conductivity and high corrosion resistance provides design and production advantages never before offered by a silicon bronze.

Test a Sample Now

Nironze 635 has been thoroughly evaluated in the laboratory and in the field to insure the high quality and top performance common to all Bridgeport alloys. To get your test samples and full technical information, call your nearest Bridgeport Sales Office. Or write us direct. Dept. 3503

Nironze 635 is presently available as rod or wire, supplied in the solution-treated, solution-treated and drawn, and solution-treated, drawn and aged.

NIRONZE PHYSICAL PROPERTIES

Density	0.320 lb/in.³
Color Red	similar to copper
Thermal Expansion	8.9 x 10⁻⁶/°F
Melting Point	1990°F
Nominal Composition:	
Copper	97.5%
Nickel	1.9%
Silicon	0.6%
Total	100.0%
Electrical Conductivity, % IACS	
Cold-drawn and aged	30%
Cold-drawn	15%

MECHANICAL PROPERTIES (Nominal)

Form	Condition	Tensile Strength psi	Yield Strength psi	Elongation % (4D)	Contraction of Area %	Rockwell B Hardness	0/0 IACS
Rod and Wire	Solution-Treated	40,000	12,000	50	90	7	24
	Solution-Treated, Aged	88,000	70,000	12	20	86	43
	S.T. Drawn 50%	65,000	62,000	18	87	67	22
	S.T. Drawn 50%, Aged	100,000	90,000	12	25	95	42
	S.T. Drawn 80%	70,000	65,000	15	85	73	22
	S.T. Drawn 80%, Aged	103,000	97,000	17	62	96	39

COMPARATIVE RATINGS OF NIRONZE 635 vs STANDARD SILICON BRONZES

	Physical Properties			Fabrication Properties			Mechanical Properties		
	Electrical Conductivity (Annealed) % IACS	Melting Point Liquidus °F	Density lb/in.³	Cold Workability	Machinability Rating %	Annealing Temp. °F	Tensile Strength psi	Yield Strength psi	Rockwell B Hardness
NIRONZE 635	*35	1990	0.320	Excellent	*30	**850-900	100,000	85,000	95
High Silicon Bronze (A)	7	1880	0.308	Excellent	30	900-1300	108,000	60,000	95
Low Silicon Bronze (B)	9	1940	0.316	Excellent	30	900-1250	90,000	67,000	90

®The term "Nironze" is a registered trade-mark of the Bridgeport Brass Company

*Drawn and aged **Aging temperature

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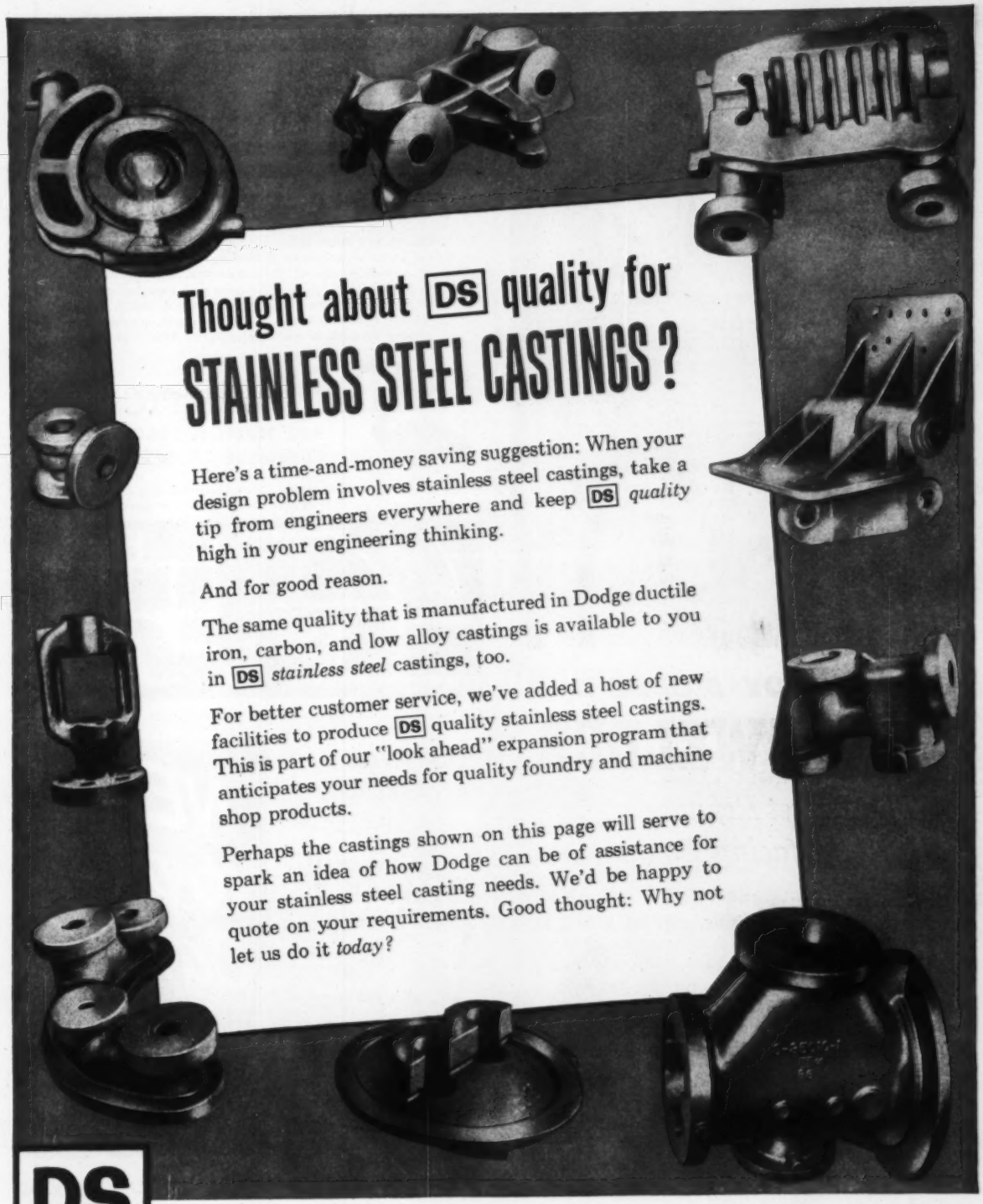

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For better customer service, we've added a host of new facilities to produce DS quality stainless steel castings. This is part of our "look ahead" expansion program that anticipates your needs for quality foundry and machine shop products.

Perhaps the castings shown on this page will serve to spark an idea of how Dodge can be of assistance for your stainless steel casting needs. We'd be happy to quote on your requirements. Good thought: Why not let us do it *today*?

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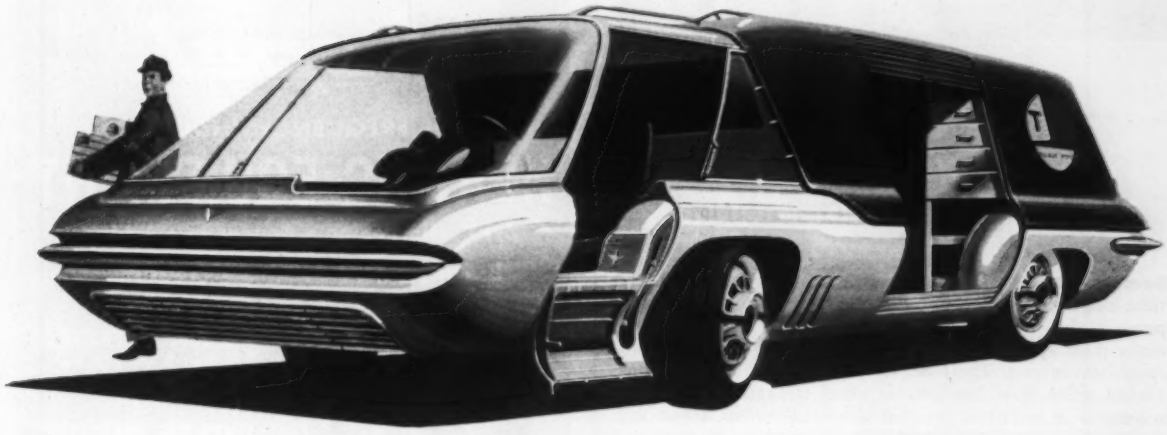

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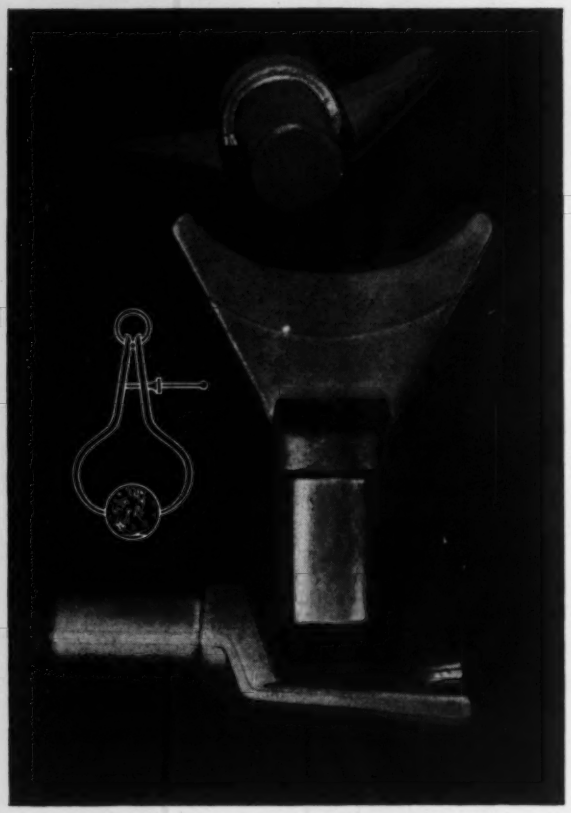

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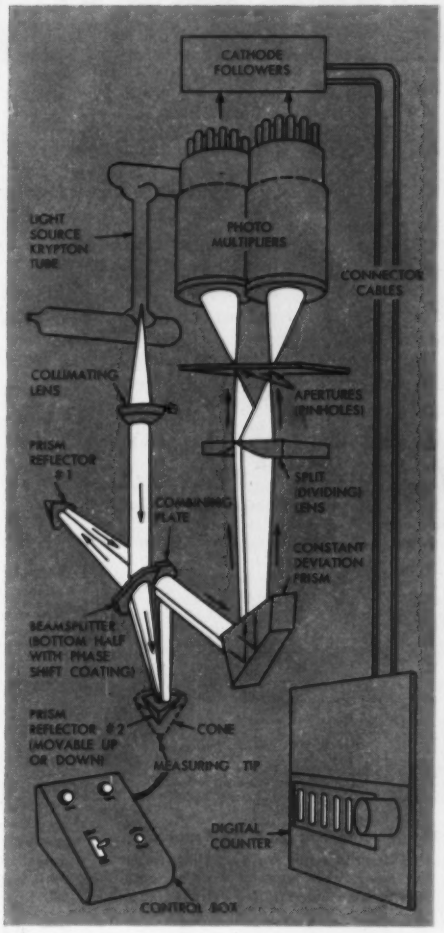

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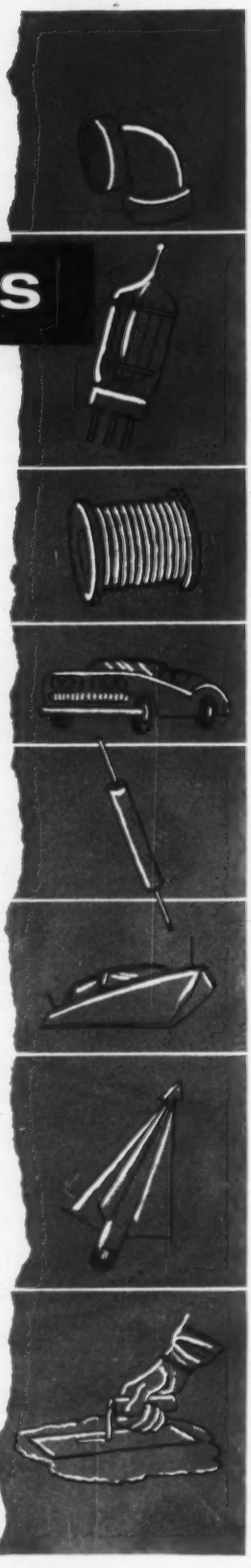

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Suggested Uses: 1—Dies. 2—Jigs. 3—Fixtures where high heat distortion, good hardness, and abrasion resistance are needed, and oven-curing facilities are needed. It can also be used for Casting Pipe Fittings.

2-C-204 Room Cure Casting Compound for Thick Sections.

Suggested Usage: A Room Cure Casting Compound for Jigs, Fixtures, Dies, Core Boxes, etc.

2-C-208 Casting and Sealant Compound.

Used for small Castings which require Electrical Conductivity. This formula has 5,000 to 18,000 ohms/inch resistance.

This material can be used as a solder for electrical connections.

2-C-214 Molding and Extrusion Compound.

Suggested Uses: Injection Molding Electrical Parts, Pipe, and many other types of Molding applications. This formula can also be extruded successfully.

2-C-215 Encapsulating Compound.

Suggested Use: For encapsulating any electrical component to give it electrical insulating resistance.

2-C-217 Protective Coating for Coil Wire.

Suggested Uses: For coating electrical wires and coils. May also be dip-coated.

2-C-218 Tube Sealing Compound.

Suggested Uses: To be used as a sealing compound for sealing ends of Capacitators and Tube Sockets. This formula is resilient and can be used where thermal expansion is a problem in Capacitators.

2-C-243 Potting Compound.

Suggested Uses: For potting of electrical components such as filter networks, audio stages, etc. This material is poured around the form to be potted.

2-C-227 White Sprayable Surface Coat.

Suggested Use: To be sprayed on the inside of a mold upon which a mold-release agent has been applied.

It is also used by brushing layer upon layer on fibre glass to build up a desired thickness, curing each coat as you go along.

This can be supplied in a variety of colors.

2-C-239 Tile Cement—Chemical Resistant Sealer for space between Tiles.

Suggested Uses: To fill space between tiles in order that the surface will have excellent chemical resistance.

2-Y-127 Concrete Floor Patching Compound.

Suggested Use: For repairing Concrete at heavy wear points.

2-C-409 Masonry Waterproofing Compound.

Suggested Use: Waterproofing material, such as on basement walls, on exterior masonry surfaces, both for decorative purposes (when supplied in pigmented form) as well as for waterproofing purposes. Cinder block wall construction may be used on a large scale with full protection provided by this liquid epoxy coating.

2-C-236 Boat Patching and Repair Laminating Compound.

Suggested Uses: As mentioned above, it can be used for repairing or covering wood or metal boats and automobile bodies.

2-C-195 General Purpose Adhesive.

Suggested Uses: Bonding metal to metal, wood to wood, plastic to plastic, etc.

2-C-199 Flexible Room-Cure Adhesive.

Suggested Uses: For bonding flexible surfaces to flexible surfaces.

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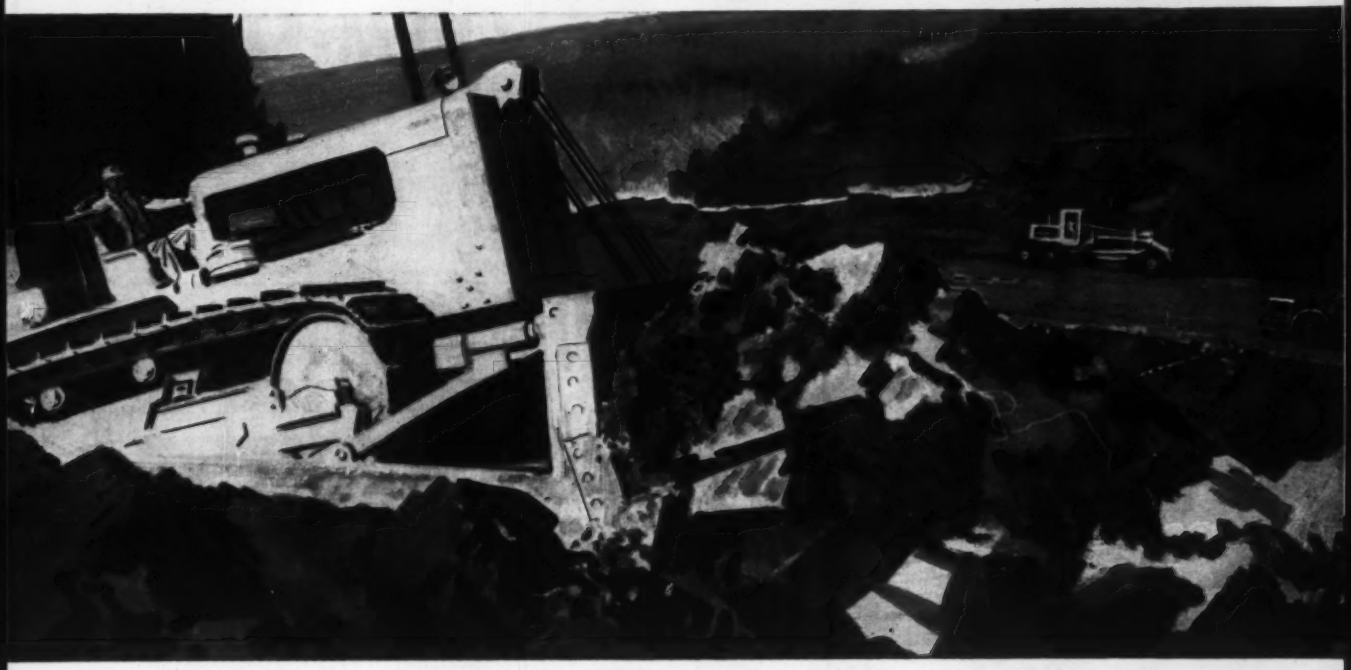

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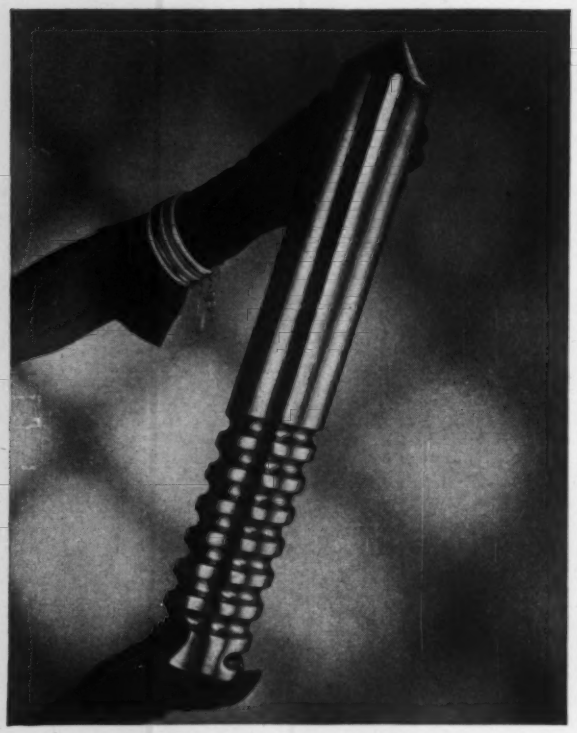

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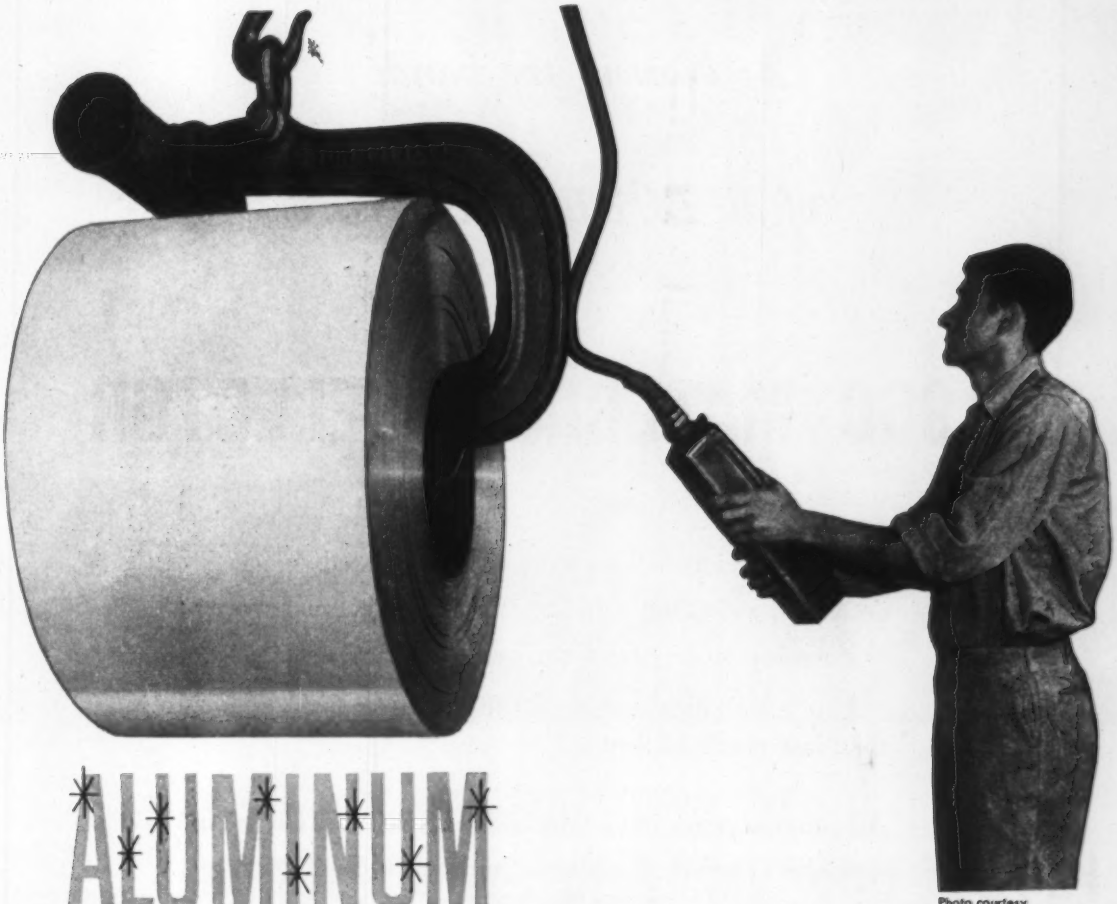

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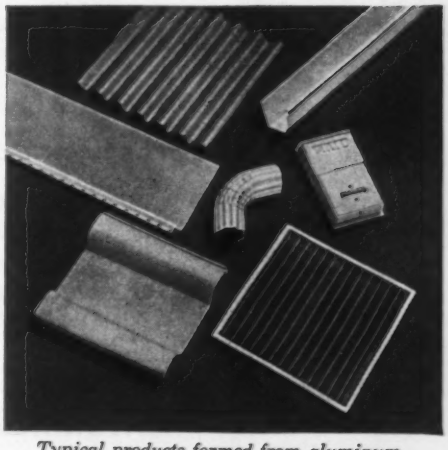

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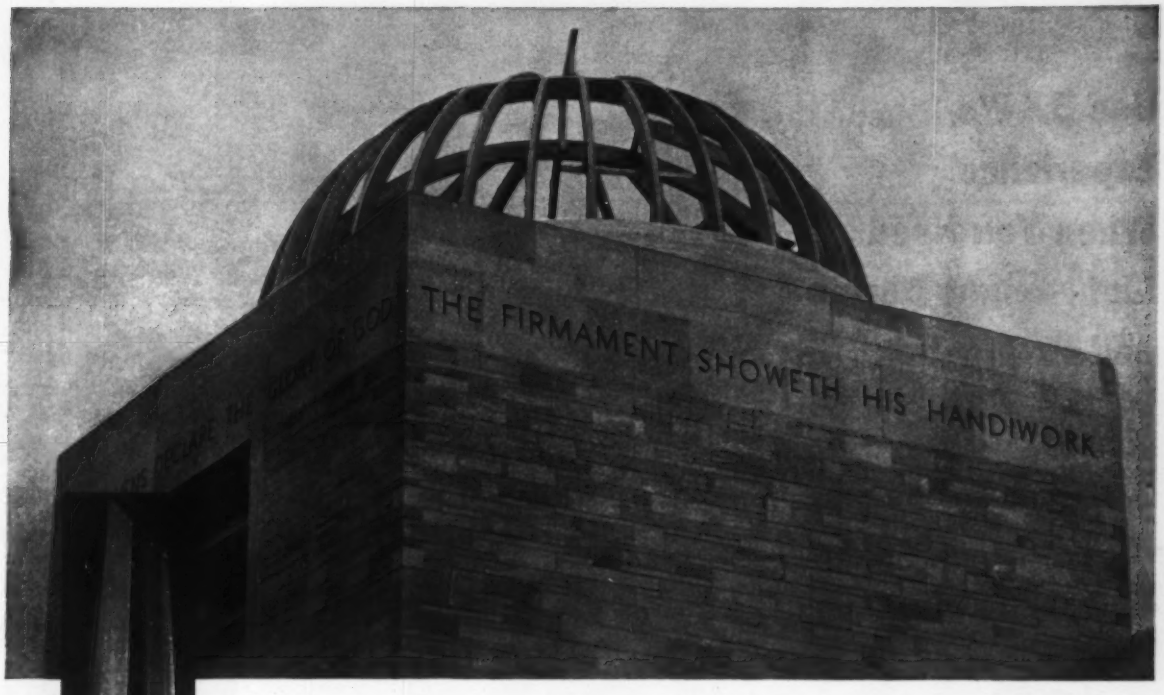

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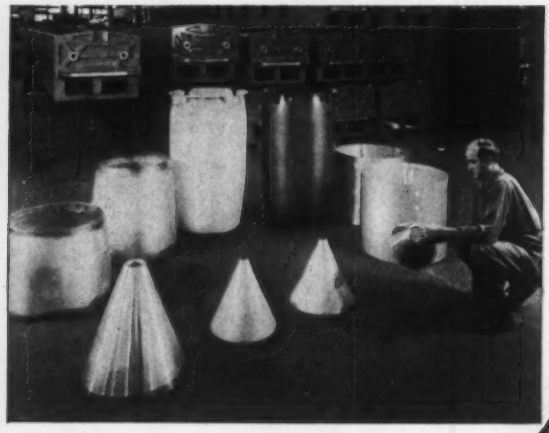

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Spaulding FIBRE FACTS FOR ENGINEERS NUMBER 3

How to Use Vulcanized Fibre for Electrical Insulation

by Earl A. Russell, Chief Engineer, Spaulding Fibre Company, Inc.

While all standard grades of Vulcanized Fibre can be used for many electrical insulating applications, the more exacting uses call for Spaulding's Electrical Insulation Grade — Armite.

Spaulding Armite is produced in thicknesses of 1/32 inch and under with a consistently higher dielectric strength than is available in other grades of fibre.

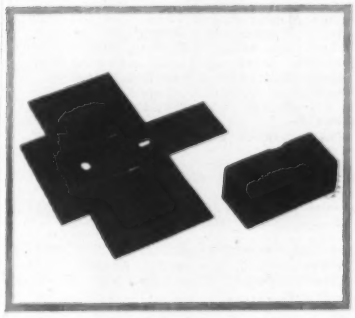
Special technical control of the manufacture of Armite makes it possible to combine this higher electrical quality with exceptional durability and forming qualities. Thus, Armite is particularly well suited for a wide range of both electrical and mechanical applications.

These uses include formed armature bonnets to insulate the windings from lead wires to the commutator, as well as for slot cell insulation in small armatures. Industry has also found extensive use for Armite in small, fractional horsepower motors. Here it is used in formed top sticks or wedges to insulate and anchor wires securely in the slots.

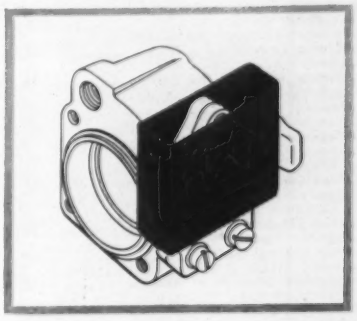
In "Barrier Insulation," the term used by Underwriters Laboratories for electrical insulation between live metal parts and adjacent live or ground metal parts, Armite finds one of its broadest applications. In this use, Armite insulators line the metal housing of electrical devices where space by itself is insufficient to provide gap insulation.

These Armite liners or "barriers" can be designed to accommodate almost any straight line contour. In .015" or .020" gauge Armite, fold lines are established economically by creasing in a punch press operation.

In thicker Armite, such as the more commonly used 1/32", score lines are punched in a fast punch press operation. This permits folding to fit neatly inside the housing box. Whether creased or scored, Spaulding ships these parts flat and ready to be formed easily by hand for insertion.



For barrier insulation as switch box liner, Armite is creased in punching operation for rapid hand forming.



For barrier insulation as removable terminal cover scored and formed, Armite is held in shape with eyelets and in place with indent at base.

In these, as in a vast range of other applications, Spaulding Armite makes it possible to design and execute finished assemblies of assured electrical qualities without sacrificing economy.

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Alderfer, Sterling, Co. 86
Agency—FRED BOCK ADVERTISING CO.
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Agency—ERWIN WASEY, RUTHRAUFF & RYAN, INC.
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Agency—KASTOR, HILTON, CHESLEY, CLIFFORD & ATHERTON, INC.
Allied Research Products, Inc. 120
Agency—EMERY ADVERTISING CORP.
Alloy Casting Institute 33
Agency—HAROLD SCHOR ASSOCIATES
Aluminum Company of America 255
Agency—FULLER & SMITH & ROSS INC.
American Brass Co. .....2nd Cover
Agency—KENYON & ECKHARDT, INC.
American Cyanamid Co., Plastics and Resins Div. 58
Agency—ERWIN WASEY, RUTHRAUFF & RYAN, INC.
American Felt Co. 26
Agency—KELLY, NASON, INC.
American Latex Products Corp. 110
Agency—RAYMOND E. WALLACE, ADVERTISING, INC.
American Lava Corp. 191
Agency—POWER AND CONDON
American Metal Climax, Inc., Amco Div. 185
Agency—MILES-SAMUELSON, INC.
American Nickeloid Co. 87
Agency—KENNETH B. BUTLER & ASSOCIATES
American Platinum & Silver Div., Engelhard Industries, Inc. 71
Agency—STUART SANDE ADVERTISING
American Smelting and Refining Co., Continuous Cast Dept. 177
Agency—NEEDHAM, LOUIS AND BRORBY, INC.
American Steel & Wire Div., United States Steel Corp. 74, 75
Agency—BATTEN, BARTON, DURSTINE & OSBORN, INC.
Ampco Metal, Inc. 201
Agency—HOFFMAN, YORK, PAULSON & GERLACH, INC.
Anchor Plastics Co., Inc. 256
Agency—RICHARD & GUNTHER, INC.
Armco Steel Corp. 66
Agency—N. W. AYER & SON, INC.
Art Wire & Stamping Co. 254
Agency—WILLIAMS AND LONDON ADVERTISING
Auburn Manufacturing Co. 268
Agency—WILLIAMS AND LONDON ADVERTISING
AviSun Corp. 257
Agency—ARNDT, PRESTON, CHAPIN, LAMB & KEEN, INC.

Babcock & Wilcox Co., Tubular Products Div. 23
Agency—O. S. TYSON AND CO., INC.
Bean, Morris, and Co. 250
Agency—ODIORNE INDUSTRIAL ADVERTISING, INC.
Bee Chemical Co. 28
Agency—SYMONDS, MACKENZIE & CO., INC.
Bethlehem Steel Co. 37, 181, 207
Agency—HAZARD ADVERTISING CO., INC.
Bishop, J., & Co. Platinum Works 258
Agency—RICHARDSON, THOMAS & BUSHMAN, INC.
Branson Ultrasonic Corp. 231
Agency—WILLIAM HILL FIELD ADVERTISING
Bridgeport Brass Co. 267
Agency—HAZARD ADVERTISING CO., INC.
Brooks & Perkins, Inc. 280
Agency—CLARK & BOBERTZ, INC.

Cameron Iron Works, Inc. 43
Agency—BOONE AND CUMMINGS
Catalin Corporation of America 93
Agency—WALTER J. GALLAGHER, ADVERTISING
Celanese Plastics Co., Div. of Celanese Corporation of America .....3rd Cover
Agency—ELLINGTON & CO., INC.
Centralab, Electronics Div. of Globe-Union Inc. 76
Agency—STRAL ADVERTISING CO.
Chemgineers, Inc. 276
Agency—JACK PACKARD ADVERTISING
Chicago Molded Products Corp. 90
Agency—MARSTELLER, RICKARD, GEBHARDT AND REED, INC.
Chromalloy Corp. 176
Agency—FAULKNER ADVERTISING, INC.
Ciba Products Corp. 173
Agency—BRIGGS & VARLEY, INC.
Clinton Co. 274
Agency—VERNON S. WEILER ADVERTISING
Coating Products, Inc. 216
Agency—LAWRENCE KANE & ARTLEY, INC.
Colonial Rubber Co. 187
Agency—RALPH GROSS ADVERTISING, INC.
Conforming Matrix Corp. 231
Agency—WENDT ADVERTSING AGENCY
Continental-Diamond Fibre Corp., Sub. of Budd Co. 70
Agency—ERWIN WASEY, RUTHRAUFF & RYAN, INC.
Continental Rubber Works 214
Agency—EUGENE C. LAIRD ADVERTISING
Coors Porcelain Co. 216
Agency—GALEN E. BROYLES CO., INC.
Copperweld Steel Co. 8
Agency—BAYLESS-KERR CO.
Corning Glass Works 107
Agency—RUMRILL CO., INC.
Crane Plastics, Inc. 270
Agency—A. LOVELL ELLIOTT ADVERTISING

Delco Moraine Div., General Motors Corp. 229
Agency—CAMPBELL-EWALD CO.
Designers Metal Div., North American Cement Corp. 266
Agency—WILLIAM J. NARUP AND CO.
Dixon Sintaloy, Inc., Sub. of Joseph Dixon Crucible Co. 212
Agency—BECH AND ASSOCIATES
Dodge Steel Co. 269
Agency—MICHENER CO.
Dow Corning Corp. 163, 164
Agency—CHURCH AND GUISEWITE ADVERTISING, INC.
Dow Metal Products Co., Div. of Dow Chemical Co. 108, 109
Agency—MACMANUS, JOHN & ADAMS, INC.
Driver-Harris Co. 221
Agency—MOGUL, WILLIAMS & SAYLOR, INC.
du Pont de Nemours, E. I., & Co., Inc., Elastomer Chemicals Dept. 101
Agency—N. W. AYER & SON, INC.
du Pont de Nemours, E. I., & Co., Inc., Fabrics Div. 115
Agency—BATTEN, BARTON, DURSTINE & OSBORN, INC.
du Pont de Nemours, E. I., & Co., Inc., Polychemicals Dept. 199, 200
Agency—BATTEN, BARTON, DURSTINE & OSBORN, INC.
Duralov Co. 174
Agency—SANGER-FUNNELL INC.
Durez Plastics Div., Hooker Chemical Corp. 261
Agency—RUMRILL CO., INC.

Eastman Chemical Products, Inc., Chemicals Div. 246
Agency—FRED WITTNER CO.
Eastman Chemical Products, Inc., Plastics Div. 88, 89
Agency—FRED WITTNER CO.
Eastman Kodak Co., X-Ray Div. 247
Agency—J. WALTER THOMPSON CO.
Eaton Manufacturing Co., Foundry Div. . 225
Agency—CLARK & BOBERTZ, INC.
Enjay Co., Inc. 80, 81, 219
Agency—MCCANN-ERICKSON, INC.
Epoxy Products Div., Joseph Waldman & Sons 213
Agency—KEYES, MARTIN & CO.
Exalco Manufacturing Co. 240
Agency—MASSO ADVERTISING AGENCY

Fansteel Metallurgical Corp. 253
Agency—SYMONDS, MACKENZIE & CO., INC.
Farley & Loetscher Mfg. Co., Plastics Div. 262
Agency—CUMMINGS, BRAND, MCPHERSON ASSOCIATES, INC.
Fasson Products Div., Avery Adhesive Products, Inc. 232
Agency—CARR LIGGETT ADVERTISING, INC.
Federal Tool & Manufacturing Co. 192
Agency—FABER ADVERTISING, INC.
Felters Co. 218
Agency—SUTHERLAND-ABBOTT
Ferro Powdered Metals, Inc. 234
Agency—MADISON ADVERTISING AGENCY, INC.
Firestone Synthetic Rubber & Latex Co. .. 68
Agency—CAMPBELL-EWALD CO.
Food Machinery and Chemical Corp. 56
Agency—G. M. BASFORD CO.
Foster-Grant Co., Inc. 72, 73
Agency—DONAHUE & COE, INC.
Frasse, Peter A., & Co., Inc. 114
Agency—PICARD ADVERTISING, INC.
Frenchtown Porcelain Co. 280
Agency—MICHENER CO.

Gamble Brothers, Inc. 279
Agency—DOE-ANDERSON ADVERTISING AGENCY, INC.
Garlock Inc. 112, 113
Agency—HUTCHINS ADVERTISING CO., INC.
General American Transportation Corp., Konigen Div. 263
Agency—EDWARD H. WEISS AND CO.
General American Transportation Corp., Plastics Div. 239
Agency—EDWARD H. WEISS AND CO.
General Electric Co., Laminated Products Dept. 54
Agency—JAY H. MAISH CO.
General Extrusions, Inc. 280
Agency—R. J. MCCALLISTER CO.
Goodrich, B. F., Chemical Co. 6
Agency—GRISWOLD-ESHELMAN CO.
Goodrich-Gulf Chemicals, Inc. 91
Agency—GRISWOLD-ESHLEMAN CO.
Goodyear Tire & Rubber Co., Chemical Div. 97
Agency—KUDNER AGENCY, INC.
Goshen Rubber Co., Inc. 179
Agency—CHAMBERLIN-JUNK ADVERTISING INC
Grace, W. R., & Co., Polymer Chemicals Div. 208, 209
Agency—CHARLES W. HOYT CO., INC.
Graphite Specialties Corp. 196
Agency—SCHEEL ADVERTISING AGENCY, INC.
Great Lakes Carbon Corp., Electrode Div. 248
Agency—DAVIS, PARSONS & STROHMEIER, INC.
Great Lakes Steel Corp., Div. of National Steel Corp. 38, 39
Agency—CAMPBELL-EWALD CO.
Gries Reproducer Corp. 252
Agency—HAROLD MARSHALL ADVERTISING CO., INC.
Grip Nut Co. 266
Agency—ROSS LLEWELLYN INC.

Hamilton Watch Co., Precision Metals Div. 242
Agency—BEAUMONT, HELLER & SPERLING, INC.
Handy & Harman 40
Agency—HAZARD ADVERTISING CO., INC.
Hull, R. O., & Co., Inc. 232
Agency—RALPH M. FRENCH ADVERTISING
Indium Corporation of America 262
Agency—FARQUHAR AND CO., INC.
Instrument Specialties Co., Inc. 186
Agency—GEORGE HOMER MARTIN ASSOCIATES
International Nickel Co., Inc. 4
Agency—MCCANN-MARSCHALK CO.

Jones & Laughlin Steel Corp., Stainless and Strip Div. 21, 196, 197
Agency—PALMER, CODELLA AND ASSOCIATES, INC.

Kinney Vacuum Div., New York Air Brake Co. 184
Agency—HUMBERT & JONES, INC.
Kopp Glass, Inc. 220
Agency—DOWNING INDUSTRIAL ADVERTISING, INC.

Lancaster Glass Corp. 178
Agency—HOWARD SWINK ADVERTISING AGENCY, INC.
La Salle Steel Co. 189
Agency—FENSHOLT ADVERTISING AGENCY, INC.
Latrobe Steel Co. 182
Agency—MCHENRY-DEREK ADVERTISING
Lead Industries Association 241
Agency—O. S. TYSON AND CO., INC.
Lepel High Frequency Laboratories, Inc. .. 272
Agency—APEX GRAPHIC CO., INC.

Little Falls Alloys Inc. 264
Agency VON DER HORST & ASSOCIATES, INC.

Maas & Waldstein Co. 175
Agency—LEWIS ADVERTISING AGENCY
Malayan Tin Bureau 250
Agency—GRAY & ROGERS
Malleable Castings Council 102, 103
Agency—CARR LIGGETT ADVERTISING, INC.
Materials in Design Engineering 230
Materials Selector 278
Marbon Chemical Div., Borg-Warner Corp. 195
Agency—HOLTZMAN-KAIN ADVERTISING
McDanel Refractory Porcelain Co. 172
Agency—MEEK AND THOMAS, INC.
McLouth Steel Corp. 271
Agency—DENMAN & BAKER, INC.
Metal & Thermit Corp. 98
Agency—MARSTELLER, RICKARD, GEBHARDT AND REED, INC.
Midland Industrial Finishes Co. 276
Agency—WESTERN ADVERTISING AGENCY
Miller Co., Rolling Mill Div. 180
Agency—GRACEMAN ADVERTISING INC.
Minnesota Mining and Manufacturing Co., Adhesives, Coatings and Sealers Div. .. 243
Agency—MACMANUS, JOHN & ADAMS, INC.
Mobay Chemical Co. 104, 105
Agency—SMITH, TAYLOR & JENKINS, INC.
Monsanto Chemical Co., Plastics Div. ..84, 85
Agency—NEEDHAM, LOUIS AND BRORBY, INC.
Mueller Brass Co. 34, 35
Agency—PRICE, TANNER & WILLOX, INC.
Mycalex Corporation of America 25
Agency—KELLY, NASON, INC.

National Carbon Co., Div. of Union Carbide Corp. 193
Agency—WILLIAM ESTY CO., INC.
National Machine Products Co. 264
Agency—HYATT EBY
National Tube Div., United States Steel Corp. 275
Agency—BATTEN, BARTON, DURSTINE & OSBORN, INC.
Naugatuck Chemical Div., United States Rubber Co. 45
Agency—FLETCHER RICHARDS, CALKINS & HOLDEN, INC.
New Jersey Zinc Co. 2, 3
Newark Wire Cloth Co. 210
Agency—SANGER-FUNNELL INC.
Northwest Chemical Co. 205
Agency—F. B. HUBERT, ADVERTISING COUNSELORS
Norton Co., Refractories Div. 64
Agency—JAMES THOMAS CHIRURG CO.
Nylon Molded Products Corp. 179
Agency—PDA ADVERTISING AGENCY

Oakite Products, Inc. 251
Agency—MARSTELLER, RICKARD, GEBHARDT AND REED, INC.
Ohio Precision Castings, Inc. 248
Agency—INDUSTRIAL ADVERTISING SERVICES
Ohio Rubber Co., Div of Eagle-Picher Co. 94
Agency—G. M. BASFORD CO.
Ohio Seamless Tube Div., Copperweld Steel Co. 60
Agency—PALM & PATTERSON, INC.
Olin Mathieson Chemical Corp., Metals Div. 62
Agency—D'ARCY ADVERTISING CO.

Page Steel & Wire Div., American Chain & Cable Co., Inc. 260
Agency—REINCKE, MEYER & FINN, INC.

Parker Rust Proof Co. 277
Agency—FRED M. RANDALL CO.
Penny Equipment Co., Inc. 256
Agency—WHEELER, KIGHT & GAINEY, INC.
Perforating Industries, Inc. 270
Agency—RAYMOND NICHOLAS ADVERTISING
Phillips Chemical Co., Plastics Sales Div. 95
Agency—LAMBERT & FEASLEY, INC.
Plastics Engineering Co. 228
Agency—KUTTNER & KUTTNER, INC.
Polymer Corp. of Penna. 236
Agency—BEAUMONT, HELLER & SPERLING, INC.
Pressed Steel Tank Co. 188
Agency—BUCHEN CO.
Pure Carbon Co., Inc. 24
Agency—JOHN HARDER FENSTERMACHER

Raybestos-Manhattan, Inc., Adhesives Dept. 96
Agency—GRAY & ROGERS
Reichert Float & Mfg. Co. 231
Agency—WENDT ADVERTISING AGENCY
Republic Steel Corp. 82, 83
Agency—MELDRUM & FEWSMITH, INC.
Revco Inc. 268
Agency—FULLER & SMITH & ROSS INC.
Revere Copper and Brass, Inc. 215
Agency—ADAMS & KEYES, INC.
Rhode Island Tool Co. 272
Agency—HORTON, CHURCH & GOFF, INC.
Richardson Co. 235
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Rochester Products Div., General Motors Corp. 166
Agency—D. P. BROTHER & CO.
Roll Formed Products Co. 211
Agency—MEEK AND THOMAS, INC.
Russell, Burdsall & Ward Bolt and Nut Co. 249
Agency—MARSTELLER, RICKARD, GEBHARDT AND REED, INC.
Ryerson, Joseph T., & Son, Inc. 122
Agency—BUCHEN CO.

St. Joseph Lead Co. 259
Agency—EMIL MARK & CO.
Sandusky Foundry & Machine Co. 245
Agency—HOWARD SWINK ADVERTISING AGENCY, INC.
Scovill Manufacturing Co. 99, 100
Agency—EDWARD W. ROBOTHAM CO.
Shenango Furnace Co., Centrifugally Cast Products Div. 190
Agency—GRISWOLD-ESHELMAN CO.
Sherwin-Williams Co., General Industrial Div. 78, 79
Agency—FULLER & SMITH & ROSS INC.
Sifco Metachemical, Inc. 183
Agency—CRIER ADVERTISING
Silicones Div., Union Carbide Corp. 244
Agency—J. M. MATHES, INC.
Simmons Fastener Corp. 42
Agency—FRED WITTNER CO.
Sinko Manufacturing and Tool Co. 264
Agency—ALLEN J. SIEGEL ADVERTISING
Spaulding Fibre Co., Inc. 281
Agency—BARBER & DRULLARD, INC.
Speer Carbon Co. 198
Agency—HAZARD ADVERTISING CO., INC.
Spincraft, Inc. 276
Agency—MAUTNER AGENCY
Stalwart Rubber Co. 194
Agency—PENN AND HAMAKER, INC.
Standard Plastics Co., Inc. 252
Agency—KNIGHT AND GILBERT, INC.
Star Porcelain Co. 272
Agency—MICHENER CO.

Superior Tube Co. 44
Agency—GRAY & ROGERS
Swedlow Inc. 203
Agency—WILLARD G. GREGORY & CO.
Sylvania Electric Products Inc., Parts Div. 116, 117
Agency—KUDNER AGENCY, INC.
Synthane Corp. 111
Agency—ARNDT, PRESTON, CHAPIN, LAMB & KEEN, INC.

Tempil Corp. 246
Agency—RAF ADVERTISING INC.
Texas Instruments Inc., Metals & Controls Div. 46
Agency—SUTHERLAND-ABBOTT
Thompson, H. I., Fiber Glass Co. 223
Agency—VAN DER BOOM, HUNT, MCNAUGHTON, INC.
Timken Roller Bearing Co., Steel & Tube Div. .....Back Cover
Agency—BATTEN, BARTON, DURSTINE & OSBORN, INC.
Tinnerman Products, Inc. 227
Agency—MELDRUM & FEWSMITH, INC.
Titan Metal Manufacturing Co., Div. of Cerro de Pasco Corp. 204
Agency—SYKES ADVERTISING, INC.
Titanium Alloy Mfg. Div., National Lead Co. 106
Agency—COMSTOCK & CO.
Torrington Co., Specialties Div. 224
Agency—HAZARD ADVERTISING CO., INC.
Troy Blanket Mills, Industrial Products Div. 237
Agency—FEELEY ADVERTISING AGENCY, INC.
Twin City Die Castings Co. 238
Agency—WM. L. BAXTER ADVERTISING

Union Carbide Plastics Co., Div. of Union Carbide Corp. 118, 119
Agency—J. M. MATHES, INC.
Unitcast Corp. 226
Agency—T. J. STEAD, ADVERTISING
United States Graphite Co. 30
Agency—PRICE, TANNER & WILLOX, INC.
United States Rubber Co., Footwear Div. 41
Agency—FLETCHER RICHARDS, CALKINS & HOLDEN, INC.
United States Stoneware Co., Plastics and Synthetics Div. 36
Agency—RALPH GROSS ADVERTISING, INC.
United States Testing Co., Inc. 206
Agency—W. L. TOWNE CO., INC.

Van Huffel Tube Corp. 69
Agency—CHAMBERLIN-JUNK ADVERTISING INC.

Wall Colmonoy Corp. 270
Agency—HEMSING ADVERTISING
Wallingford Steel Co. 273
Agency—HUGH H. GRAHAM & ASSOCIATES, INC.
Washington Steel Corp. 10
Agency—CABBOT & COFFMAN, INC.
Waterbury Rolling Mills, Inc. 202
Agency—EMIL MARK & CO.
Waukesha Foundry Co. 217
Agency—CHANDLER'S
Werner, R. D., Co., Inc. 233
Agency—BAYLESS-KERR CO.
Wilson Mechanical Instrument Div., American Chain & Cable Co., Inc. 222
Agency—REINCKE, MEYER & FINN, INC.
Wolverine Tube Div., Calumet & Hecla, Inc. 77
Agency—GRAY & KILGORE, INC.
Wyman-Gordon Co. 265
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Yoder Co. 92
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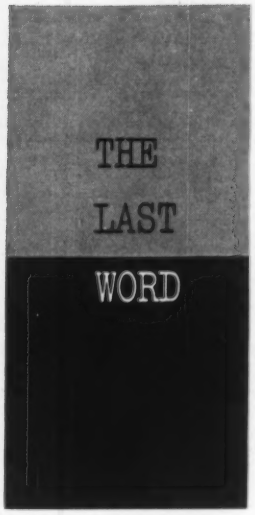
The Materials Barrier Is Growing—How Do We Break Through?



by ***H. R. Clauser***
Editor

We are up against a serious materials barrier. Despite the Government's sizable expenditures on materials research (estimated at from 300 to 500 million dollars annually), important defense, atomic energy and space programs are still being held up because the presently available materials are not adequate to meet the severe temperature, pressure, radiation, corrosion and stress conditions of our advanced technology.

Top committee has tackled problem

The existence of this materials barrier has been well recognized for some time now. But the reasons why it exists and what should be done about it have not until recently received the serious study the problem demanded.

About a year ago a special Committee on Scope and Conduct of Materials Research was set up by the National Academy of Sciences–National Research Council to appraise the total materials research picture. The committee, composed of prominent materials men from the fields of Government, industry and education, have now issued their report.

Present research falls short two ways

The title of the report, "More Effective Organization and Administration of Materials Research and Development for National Security," points up what we think are the two major deficiencies in our national materials development effort:

First, there is insufficient coordination in planning the vast number of research projects being sponsored by various Defense agencies. As the report indicates, there are more than 20 different offices which can approve materials research and development contracts; and several of these have a number of subdivisions with the authority to make contracts.

More centralization is needed

Although some forward steps have been taken, such as the establishment of the Materials Coordinating Committee now operating in the Pentagon, there is clearly further need for strengthening liaison and coordination among and within agencies to avoid overlap and duplication of effort. To achieve this, the "scope" committee has recommended that definite steps be taken within each agency to gain greater centralization of responsibility for research.

The second, and perhaps a more serious, deficiency in our materials development effort has been the relatively small emphasis placed on solving long range problems, and the reluctance to undertake materials research programs as end-object programs in their own right. This reluctance has stemmed from the lack of centralization of materials research, mentioned earlier, as well as the reliance on "crash" programs to meet the urgent demands for materials for specific products and equipment.

Thus, at least one-half of our materials development effort has been subordinated to end-item projects. It is true that in most cases "crash" programs have been the only way to get the job done. However, the "scope" committee reports that the effectiveness of this approach is rapidly diminishing. In fact, while short-term problems are being solved, the materials barrier is growing higher.

Broader, earlier attacks must be made

So, if we are to successfully reduce the materials barrier, larger, broader and more basic materials programs must be initiated well in advance of anticipated needs. The committee recommends a number of steps. Among these are 1) assigning to an agency in the Executive Office of the President the responsibility of seeing to it that broad materials problems of general interest are attacked by the various Government agencies on a coordinated basis, and 2) provide for centralized funding from regular appropriations for development of new and improved materials with broad application.

The report contains other recommendations of far-reaching importance that we cannot go into here. It is an important document and deserves the careful reading of all those concerned with the development and use of engineering materials.

CELANESE MATERIALS REVIEW

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- **FORTICEL cellulose propionate**
- **ACETATE molding compounds**
- **ACETATE sheeting**
- **POLYESTER resins**

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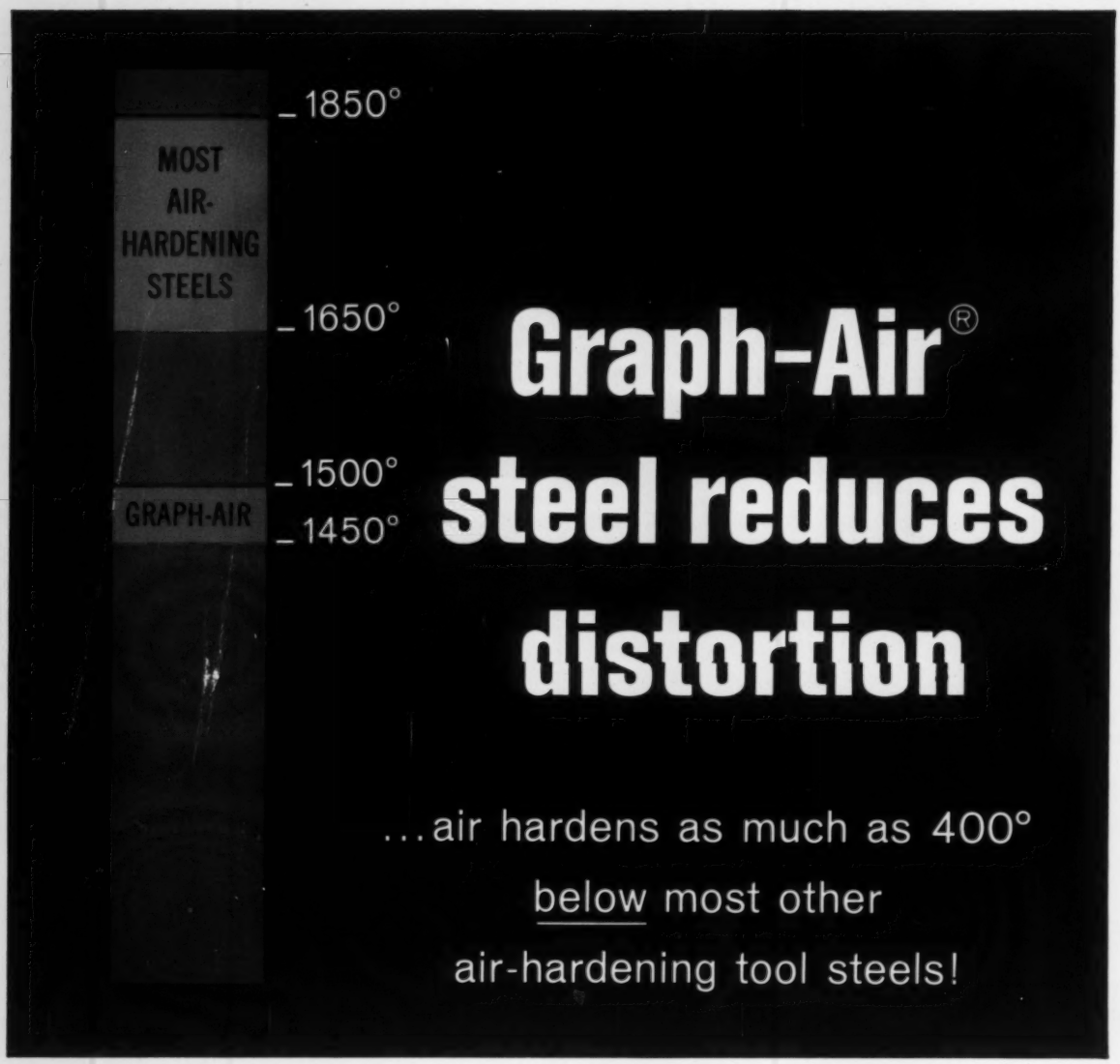

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